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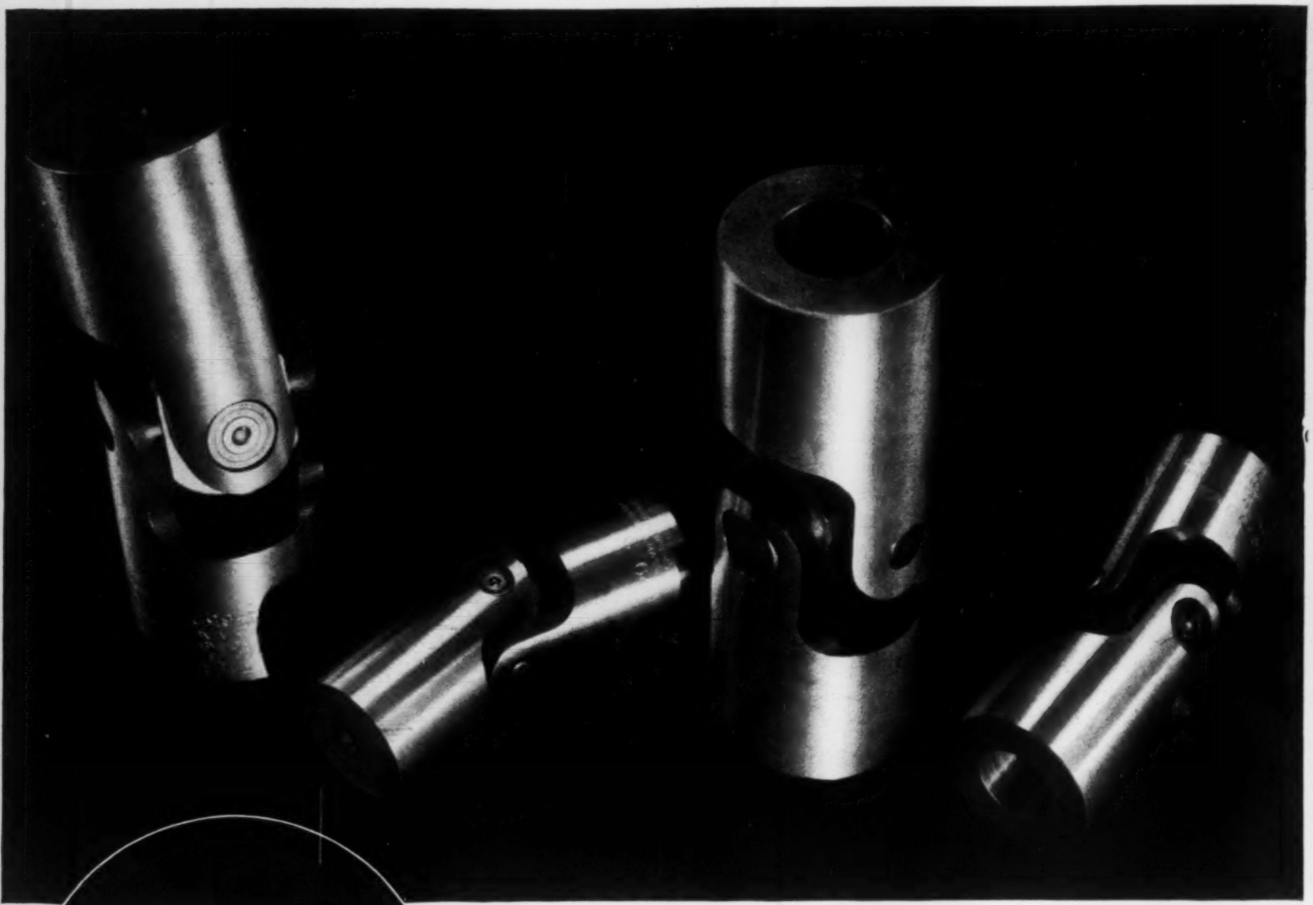

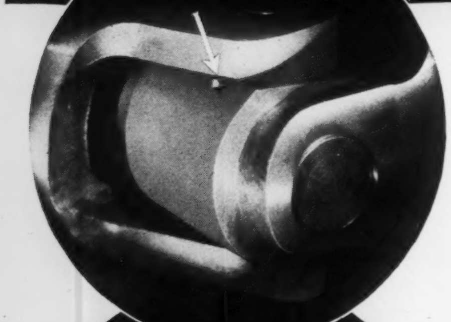

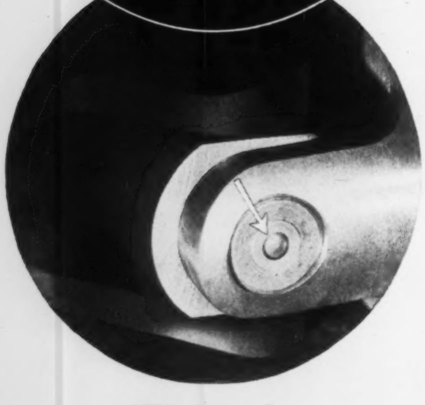

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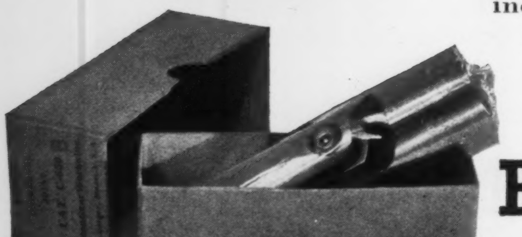

BOSTON GEAR WORKS, INC.

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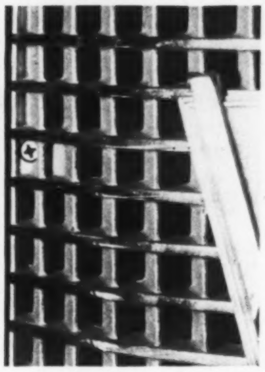
SAFETY
ZONE
~~GO FAST~~

Phillips Recessed-Head Screws end danger of accidents from slipping drivers — so designers can help manufacturers cut assembly time up to as much as 50%!

O DANGER of TORN CLOTHING

hillips Screws can't be urred by the driver.



EXTRA PARTS ELIMINATED

Phillips Screw ended need of locking device.

Using electric or pneumatic drivers to assemble parts already finished was much too risky before the Phillips Screw with its recessed head came along. Now design engineers in many screw-using industries are specifying Phillips Screws — which end the danger of the driver jumping from the screw and slashing a gouge across the finish — and faster driving methods are safe to use. The tapered point of the Phillips Driver holds in the screw's tapered recess.

Designers can also count on Phillips Screws for increased holding power. Easier driving and elimination of pilot holes often make it possible for you to specify fewer screws or smaller, lower-cost sizes. Where appearance is a factor, Phillips Screws also present an added selling point.

Send for Folder B, containing more Ideas for Designers. Address one of the firms listed below.

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Gain Time . . . Guide-Driver . . . Guard Work

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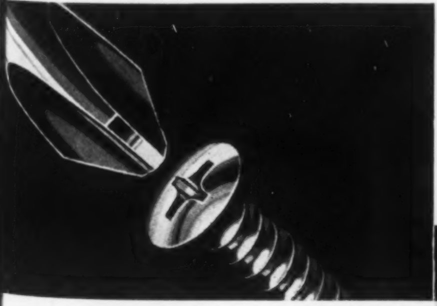

This is the genuine patented Phillips recessed head

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Note the tapered recess in the screw — its angle was rked out after months of tests to determine the most cient form of recessed head, utilizing the driver's *ximum* turning power. Note the flat surfaces — no ves except at the rim. That prevents the driver from ring the screw. Cold forged to tolerances of plus or nus .001" — to guarantee a perfect fit.

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Send Coupon for FOLDER B — containing at least a dozen ways Phillips Screws can lower your assembly costs. (Address your inquiry to one of the firms listed above.)

Name...

Company..

Topics

INDUSTRY learned after long and painful years of scrapping that a measure of co-operation between companies making different or even related products is a beneficial tactic to employ. Hundreds of meetings and technical conventions are held annually for the free exchange of ideas between engineers, and every effort is made in scientific and trade journals to report design innovations of all kinds to the civilized world. Company and trade secrets are passing from the picture and in their place we find a more tolerant and co-operative attitude which has worked to the advantage of both industry and the public. In times of lessened business activity it is particularly appropriate that companies should work together in opening new sales fields and we believe that research carried on by a single body for the benefit of interrelated industries serves a worthwhile purpose. One chemical company, in particular, has just issued a booklet on "interrelated research" pointing out that "where the products of a group of companies are related in character, there is an opportunity for co-ordinated research." Such research brings the experience and knowledge gained in one field to the solution of the problems of another," the booklet states. Certainly some type of co-ordinated effort is necessary if we are to hold our own in these present chaotic times.

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Forgings of molybdenum steel for pistons and side rods, weighing about half as much as these parts ordinarily do, are being used on the New York Central's new streamlined Twentieth Century locomotive put in service last month between Chicago and New York. Another forged part which departs from the standard type used for many years are the couplings on this train. Of the "tight-lock" type, their connection eliminates all slack between the cars and prevents the snap and buck so often noticed when a train starts. Larger and more powerful forging equipment enables manufacturers to produce forged parts that were considered impractical or too costly a few years ago. The railroads, which use many forgings, are quick to heed these advances and engineers are specifying the improved part on their new equipment.

As boats, airplanes, and other machines are constructed larger and larger, we sometimes wonder when, if ever, the limit will be reached. One consideration which has not particularly bothered designers until they reached the massive stage of precise design construction is the expansion and shrinkage of large parts. This problem is now confronting engineers at the East Pittsburgh Works of Westinghouse Electric & Mfg. Co., where the finishing grinding touches are being put on the 46-foot diameter bearing to be used in the 200-inch telescope in California. Due to the heat of the sun there is a difference of twelve-thousandths of an inch in the daytime and night-time size of the structure. Grinding tools must be adjusted as the shop gets hotter during the day and readjusted as night falls. Skylights on the roof of the shop in which the huge bearing is housed have been painted green to deflect the direct rays of the sun. The problem presents a rare opportunity for an air conditioning application to keep the shop at exactly the same temperature day and night.

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We only regret that this page does not permit a colorful graph showing the increase in diesel horsepower sold in the United States since 1932. The advance is astonishing. First marketed in this country in 1903, by 1932 diesel engine sales amounted to only about 100,000 horsepower that year. This was a recession from the high point of 1928 when 500,000 horsepower were sold. Five years later, however, in 1937, diesel horsepower sales in America had jumped to 2,000,000. Though initial cost is considerably greater and operation is more complicated than the conventional gasoline engine the savings in fuel attract many buyers. Caterpillar Tractor Co. deserves much credit for this tremendous increase, for in 1932 tractors manufactured by this company were first equipped with diesels as standard equipment. Since then many other companies have turned to diesel power and there is every reason to believe that in a few years the diesel engine will seriously invade the passenger car field. In Europe it is being used today for airplane, truck and passenger car service.

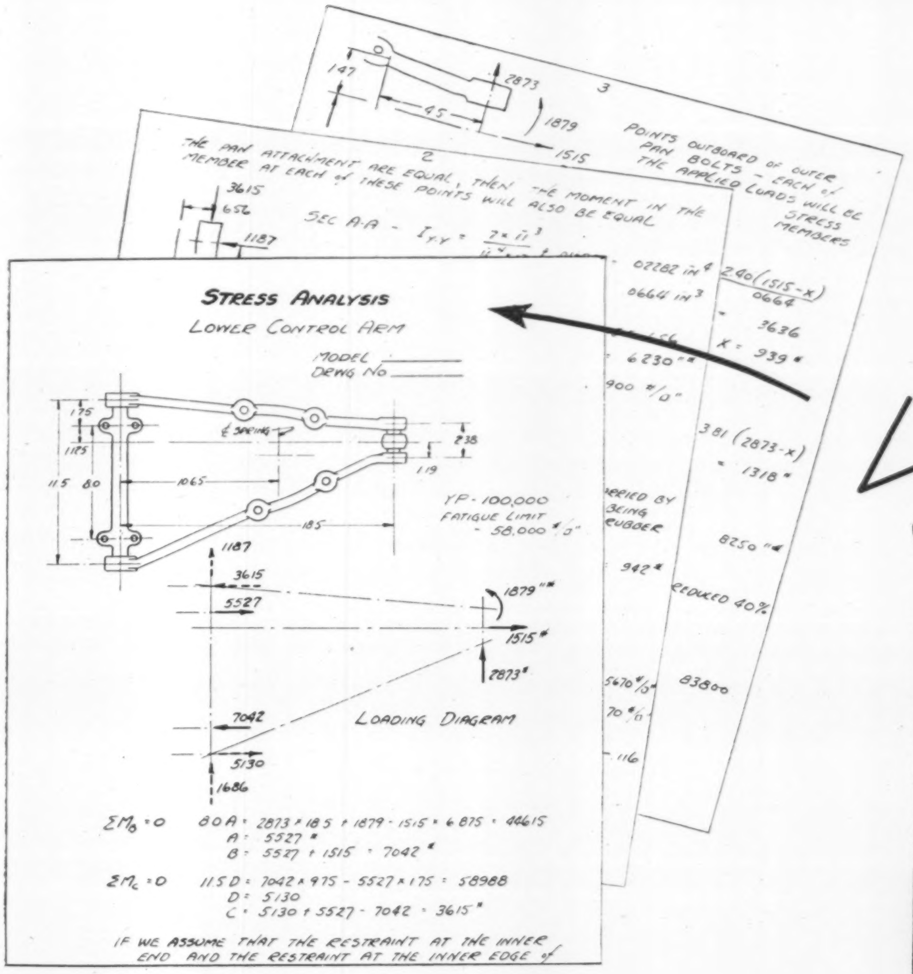
MACHINE
DESIGN

Be Doubly Sure—

Test It!

PART I

By
A. W. Ross Jr.*



3

POINTS OUTBOARD OF OUTER PAN BOLTS – EACH OF THE APPLIED LOADS WILL BE STRESS MEMBERS

2

THE PAN ATTACHMENT ARE EQUAL, THEN THE MOMENT IN THE MEMBER AT EACH OF THESE POINTS WILL ALSO BE EQUAL

SEC A-A – $I_{Y\text{-}Y} = \frac{.7 \times .11^3}{}$

.02282 in⁴

.0664 in³

$\frac{2.40(1515-x)}{.0664}$ = 3636

x = 939 #

6230 "#

900 #/□"

3.81 (2873 - x) = 1318 #

...RRIED BY ...BEING ...RUBBER

8250 "#

942 #

REDUCED 40%

5670 #/□"

83800

70 #/□"

.116

STRESS ANALYSIS

LOWER CONTROL ARM

MODEL ______
DRWG NO ______

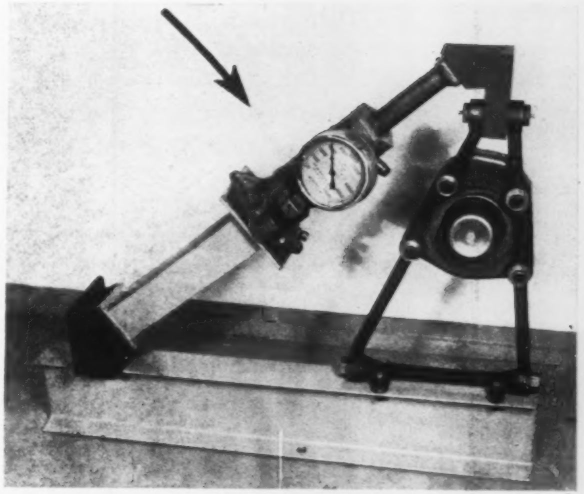
YP - 100,000
FATIGUE LIMIT - 58,000 #/□"

LOADING DIAGRAM

$\Sigma M_B = 0$ 8.0 A = 2873 × 18.5 + 1879 - 1515 × 6.875 = 44615
A = 5527 #
B = 5527 + 1515 = 7042 #

$\Sigma M_C = 0$ 11.5 D = 7042 × 9.75 - 5527 × 1.75 = 58988
D = 5130
C = 5130 + 5527 - 7042 = 3615 #

IF WE ASSUME THAT THE RESTRAINT AT THE INNER END AND THE RESTRAINT AT THE INNER EDGE OF



Figs. 1 and 2—Data necessary for calculations of stress in an independent front wheel member are indicated at left. Test set up for same problem is shown above. The simple test eliminates assumptions of internal and external fixity and of variable section and deflection characteristics are obtained directly

STRUCTURAL testing has established for itself a definite place in many branches of industry. Considered particularly important today are tests of the complete primary structure of new airplane designs as insisted upon by the Army and Navy. Structural steel is designed by analytical methods but civil engineering records carry ample data to verify the empirical formulas that are used in the calculations, and tests have been conducted on full size columns, girders and structural details. Models often are used for bridge analysis. The primary structural parts of railroad car trucks are

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* *Engineer in charge, Structures Laboratory, Chrysler Corp.*

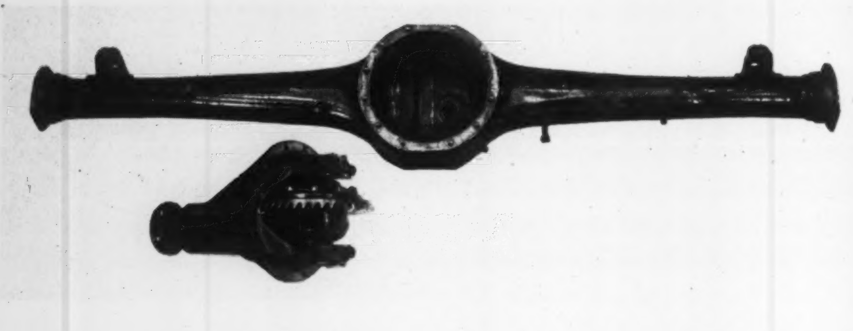

Fig. 3—Rear axle housing is an important beam that must be strong and rigid. Differential carrier when bolted in place reinforces beam and, in turn, is reinforced by housing. Testing provides the means for establishing these reinforcing effects

thoroughly proved by test. Current technical literature includes detailed descriptions of structural tests of automobile chassis frames and body-frame assemblies.

In the general field of machines, primary structural parts such as frames, housings and supporting structures may be conservatively analyzed for their loads, but many parts and assemblies with a structural function never receive adequate strength or rigidity verification before being released for service. This does not necessarily mean that the structures are inadequate. The opposite is usually true, resulting in excess material from conservative design with corresponding penalties of weight and cost. Tests are a tool for the attainment of efficient design.

STRUCTURAL TESTING covers static testing of units or assemblies under conditions that duplicate, as nearly as possible, the actual service conditions to which the part will be subjected. Laboratory vibration and repeated load tests also come under the general subject. *Fig.* 2 is a conventional set up for testing an automotive front wheel suspension part.

Excluded are flight, road or service testing and materials testing. The function of the "Materials Testing Laboratory" usually is the determination of the physical properties of materials, the checking of the material content of production parts to specification and the routine testing of parts (obtained by sampling from production) to specifications which often are of an arbitrary nature and designed more to demonstrate the properties of the material of the part than to verify the design.

Structural testing, then, is either research or special, as compared to materials testing which is production or routine.

Why should the parts manufacturer who works to drawings and specifications submitted without option be interested in tests of his product? Is there any reason for the manufacturer of mechanisms or parts who has a satisfactory market for his product as designed to concern himself with proving its strength? Or has the purchaser any need for test data when he can accept a particular design with confidence in its strength and rigidity as demonstrated by an impressive service record? Recognizing the advisability of close design, why, with well-established analysis theory, should we resort to testing?

Of first importance is the part test programs can play in influencing design toward lowered costs. Tests not only demonstrate ample strength but establish the existing margin of overstrength. Design revisions making for simplification and weight reduction result from proper interpretation of test data; thus the lowered costs are realized. Enlarged markets and increased profits are the obvious advantages.

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THIS article is the first of three by Mr. Ross on structural testing of machine parts. Part II will cover testing to influence design and Part III will deal with methods of conducting the simple structural test. The author is associated with the Chrysler Corp. and his illustrations have been taken primarily from the automotive field. However, the examples have been carefully selected to be of interest to the designers of machines in general. Mr. Ross has been actively engaged in stress analysis and structural testing for more than 10 years and is one of the outstanding engineers in his field

◆

Reduction in weight has an advantage in itself, exclusive of effect on cost. The importance of light weight in design is rapidly gaining its proper recognition. Weight influences handling and shipping costs, controls the design of supporting structure, and establishes the performance of such units as airplanes and automobiles. It also is an important factor in the design, performance and service life of machines in general. Tests establish strength within close limits permitting design with minimum weight.

Test data on a product gives the engineer salesman additional ammunition for his work that is invaluable. A properly prepared test report, clearly written, briefly stated, and illustrated with photographs; a report that demonstrates without question the strength, rigidity and efficiency of a product, will make sales. Can your sales representative answer these simple questions: How strong is it? Is it rigid enough for our requirements? Is this as light as it is possible to make it and still be safe?

Designers, on the drafting board, work from the knowledge available to them. Experience forms the

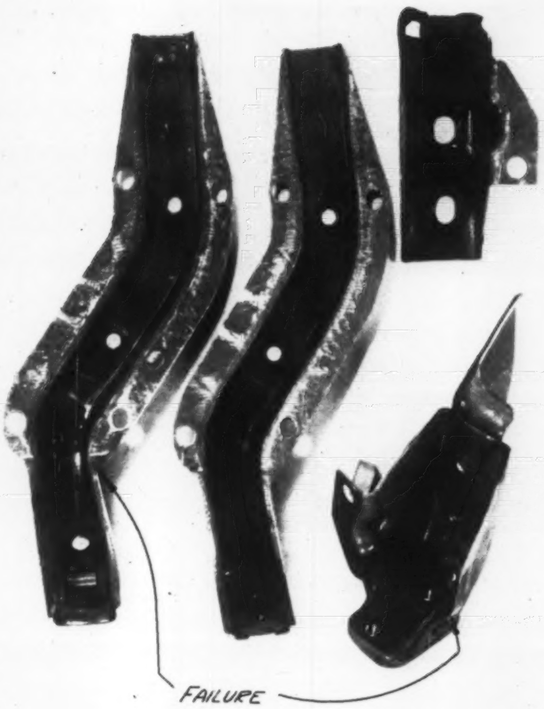
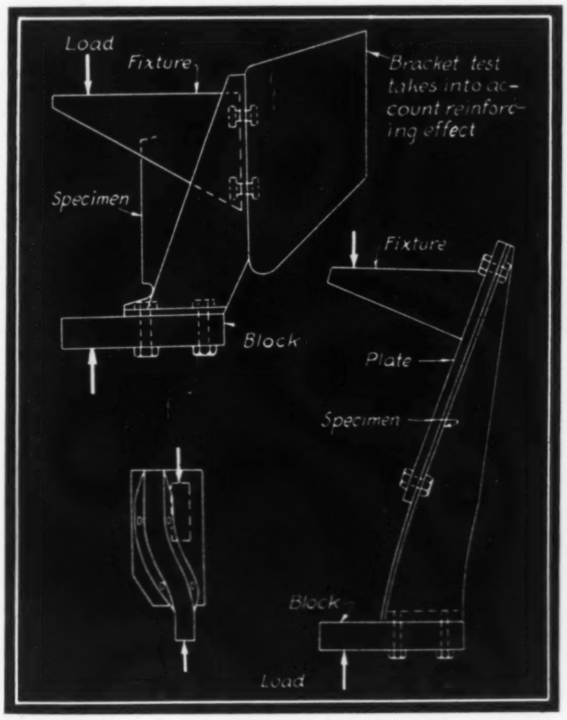


Fig. 4—Sample stampings often are difficult analysis problems—tests provide the means for accurately determining the ultimate strength. Upper view depicts stampings to be tested and bottom view is of the test assembly



major part of this knowledge. Text books and articles amplify it and stress analysis may dictate required sections. But let a designer *witness* a test to destruction of a part which he has fathered on the drafting board. Here is firsthand experience, often directly applicable to later problems, and education that impresses and sticks. You can hear an enthusiastic "That certainly is the way to see just what happens!" from the witnesses of a well-staged test.

Tests also can arouse executive interest, either through well written reports or by their actual presence at the finales of important demonstrations.

Thus, in structural testing, we have a tool with more than one function:

(a) It gives us a reasonable method of improvement of a current product.

(b) It permits us to set up alternate and more efficient designs, with proof of superiority that cannot be ignored.

(c) It supplies invaluable sales material.

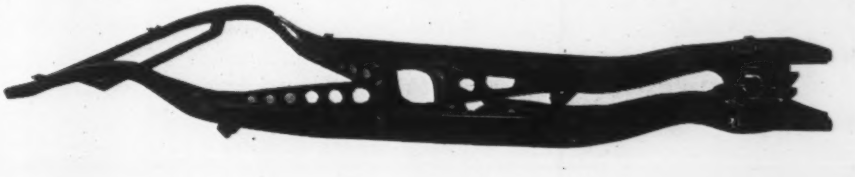
The author believes there are important reasons for testing even where precise stress analysis procedures already have been applied and beyond the fact that tests have a certain value as an attention-getting demonstration. Limitations of stress analysis will be critically analyzed in this article, and testing will be presented as a practical means of reducing assumptions so that a more accurate picture of structural characteristics can be obtained and used to fullest advantage in design.

TEST SPECIMEN—The usual structural test specimen is visualized as of steel: A casting, a forging or a built-up section of structural shapes welded, bolted or riveted together. "Test specimen" seems to suggest a small compact unit.

In this series of articles, test specimen is intended to include a broader field as well as the specimens described. It may be a complex assembly of composite construction, as indicated by the accompanying illustrations. Far from being limited to steel or even metal, the specimen may include rubber, which may very well have an important influence on deflection and load distribution. Duralumin or aluminum may be combined with steel; and wood continues to be an important part of many structures. Our test specimen may be expected to include and consider parasitic structure whose structural function is entirely secondary but may well influence the strength of the assembly.

Plastics, as structural materials, are coming rapidly into their own, being used as frames and housings

Fig. 5—Automobile chassis frame is excellent example of complex structure. It is difficult to analyze stresses as this is a redundant structure made up of members of variable section which introduce stress concentrations



of numerous assembled products. The fabrication processes are such that they permit complex structures without cost penalties. With less rigid form limitations, extremely economical structures can result from proper design. Moreover, test specimen most certainly includes parts or assemblies of thin metal of irregular form dictated by other than purely structural consideration. (See *Fig.* 8). Our test specimen, then, may cover units ranging from a simple bracket to a complete machine.

STRESS ANALYSIS VS. TESTING—The following discussion may convey the impression that stress computation is so limited by its assumptions as to be extremely inaccurate and actually dangerous in some cases. This of course is not true when analysis procedure is properly handled by competent men. The experienced analyst realizes the limitations of the methods he applies and provides ample margins for structural safety. It is this margin however which, by establishing actual strength more closely, can be reduced with corresponding saving. Testing can be shown to be a proper tool for reducing this margin. Testing can eliminate many assumptions which analysis must make allowance for by margins of safety.

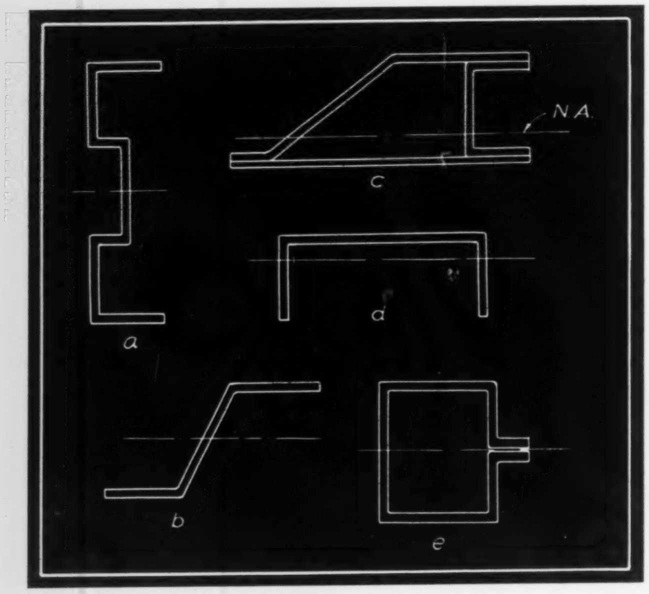


Fig. 6—Tests provide a proper means for evaluating strengths of such parts as these which fail to develop their full strengths as computed by usual theory

It is intended to show the place of testing beside and in co-operation with analysis rather than as a new procedure replacing an obsolete one.

The preceding paragraphs on "Test Specimen" in themselves bring out obvious applications for a reasonable test technique. Complex structures, assembled structures, members with attached parasitic structure that functions structurally, composite structures (particularly where rubber transmits load between metal parts), and structures of thin metal. Such structures by their very nature are complex analysis problems, requiring assumptions and precise solutions that may be expected to introduce error and hence call for margins of safety. Testing reduces such assumptions to those of exterior loads, fixities and supports.

The author has witnessed the test of an airplane spar of girder type with plates added to the web at critical points. Failure occurred at the end of one such reinforcement (stress concentration) although the margin over the required strength as determined by analysis was as much as twenty-five per cent and other sections with zero margins did not fail. Tests of structures that consisted of tapered members and undetermined joint fixities have been shown by test to exceed by five times the results anticipated from analysis due to conservative assumptions of moment of inertia and fixity. Other parts have failed at half the analysis load due to local failures that the analyst failed to anticipate. Many production parts are carrying a cost and weight penalty because of margins provided to take care of analysis limitations. A relatively simple test could establish a basis for more economical design.

External Forces Must Be Dealt With

EXTERNAL FORCES—DIRECTION AND DISTRIBUTION—If our test specimen consists of only the single unit that is the subject of what would be a paralleling stress analysis, then the assumptions of external force direction and distribution are identical for both analysis and test. Where the primary test specimen is surrounded by the actual parts which attach to it and through which the loads are introduced into the specimen, then some further refinement must result. But in most cases load direction and distribution are closely defined and assumptions do not introduce serious error.

EXTERNAL FORCES—MAGNITUDE—Some discussion of load factors and design loads will be included in Part II of this series. By their very nature they must be obtained by a consideration of the service conditions and functions of the part. Any assumptions that apply to analysis are equally applicable to test.

EXTERNAL SUPPORTS AND FIXITIES—Support locations usually are well defined and can be established for test or analysis with equal accuracy. However, the fixity at these points is not so easily established. Analysis relies on assumption. Similarly, tests may require assumption, and attachments to jigs and fixtures may be fixed or pinned as the assumption dictates. Where joints are bolted or riveted or of a design easily duplicated, then the test can be refined by duplicating, as nearly as possible, the actual joints. In many cases it is entirely feasible to surround the part with the actual parts to which it assembles and obtain the fixities that actually exist in service. Thus, it is possible by test to reduce or actually eliminate the assumptions of external fixity.

In any case, the assumption of internal joint fixity, which are essential to analysis, are eliminated by test.

Redundant Structures—A simple structure is one having just sufficient members and rigid joints to make it complete. The addition of one or more members or fixities to a simple structure makes that structure redundant and a solution is termed indeterminate. The truss with fixed joints is redundant and the stresses resulting from the fixities are termed secondary stresses, as distinguished from the primary stresses computed by determinate methods assuming the joints pinned. The solution of structures made up of conventional straight members and of known fixities can be reached by precise methods with reasonable accuracy but require laborious and lengthy calculations. Solutions can be simplified by assumption, the extent and nature of the assumptions being determined by the accuracy required and the time available. For a precise solution, every redundancy introduces an unknown. By setting up simultaneous equations, one for each unknown, and solving, a solution is obtained.

Static Tests Solve Redundant Structure

Redundant structures also result when two parallel parts function to support a single force. Such a condition exists when the primary structure is supplemented by an external shell of thin metal. The use of different materials in an assembled unit increases the unknowns.

A static test solves the redundant structure as easily as the simple one, for the set up is made no more elaborate by complexity of the specimen. All assumptions regarding properties of sections, fixities and stress distribution within the specimen are eliminated.

Members of Variable Section—For some simple cases of members of variable section there is available a precise graphical method of solution. Other than this, general practice accepts a conservative assumption of a value for the average moment of inertia of the member. Test considers the tapered member without assumption.

Local Failure—The use of the phrase "Form Factor" has found a place in the aircraft vocabulary. Form Factor, as a numerical factor, is understood to be some value less than 100 (per cent) which represents the part of the strength, as computed by usual theory, that the member can be expected to develop. Column strengths that fall below the theoretical Euler or the empirical Johnson, straight-line or Rankin curves have been termed crippling strengths. The general term "Local Failure" includes all conditions of local buckling due to the use of thin-gage material.

There is available, for certain simple restraint conditions, theoretical solutions of the buckling of flat plates and shells. As the form or support becomes more complex, this theory is very inadequate.

Fabrication of parts has an important influence on strength. That is, slight irregularities in the unstressed part such as waves or buckles, indentations at driven rivets, or warped surfaces due to heat treatment cause strength reduction. Internal stresses in the assembled part affect the ultimate strength.

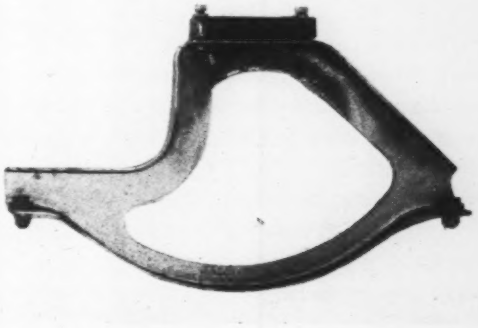


Fig. 7—Simple motor support easily tested for strength. Test considers the lack of lateral support and local weakness of curved flanges and webs of thin material

Rules that establish thickness to unsupported width ratios limit structural steel design to safe proportions. The proportions of structural rolled sections are such as to keep them outside the range of local failure.

However, with light weight at a premium, thinner and thinner gages are being used. Particularly in the airplane field, designers are dipping farther and farther below the dividing line that separates design accepting local failure and design that does not. Only by accepting local failure can economical design be realized. Theory is being built up for the more regular structures but for shells, whether curved, offset or irregularly supported, there is no applicable theory. This is no reason to ignore the strengths of such shells and fail to avail ourselves of the strengths of such structure as exists. Testing technique makes no distinction between simplicity and complexity of structure.

Form Factor in Heavy Sections—The term "Form Factor" applies to a certain class of sections, regardless of thickness of material, that fail to develop their full strengths as computed by usual theory. And these cannot be properly classed as local failure. *Fig.* 6 shows several such sections. They have one feature in common, that the webs are so located with respect to the flanges or so sloped, without adequate structure to absorb the lateral thrust from these webs, that the properties of the flanges are not fully developed. Tests provide a proper means for evaluating the strength. The strength of the member *e* would be greatly increased by welding the flanges. This example is an obvious one but the general principle often is overlooked in practice.

Stress Concentration—Stress concentration is being given much-needed attention. All the tricks of photoelasticity are being directed toward obtaining data on concentration. But just at present, holes and fillets are being given the most consideration. Local reinforcements introduce more or less important stress concentrations analysis cannot anticipate.

Modulus of Rupture—In bending, beams develop indicated stresses that often exceed the ultimate tensile strength of the material. This difference is explained, in part, by the inaccuracies of the assumptions of simple beam theory; and a term, Modulus of Rupture, has been coined to apply to the allowable stress in bending based on computations by this theory. The value is not a definite one but depends on the form of the section as well as upon the properties of the material. The increased allowable stress is recognized by the Army and the modulus of rupture has been established for bars and tubes; but there is no data or theory that applies to all irregular forms.

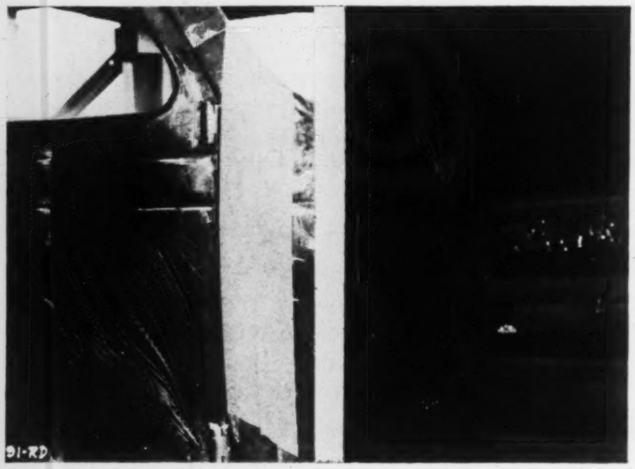


Fig. 8—Ends of louvres and offsets in the shell are sources of stress concentration. Panels of light metal may carry load or be subject to vibration. Photograph obtained by coating metal with resin and introducing stress. Cracks indicate potential points of failure

Properties of the Material—For analysis purposes, the properties of the material are taken as the lower limit of the specifications; this is the proper procedure. For test purposes, the sample furnished may be of material with properties anywhere within the limits of the specifications. The actual properties of the part tested can be obtained easily by a hardness test, or a sample cut from the specimen can be tested to obtain tensile and yield point stresses.

Consideration must be given the type of failure when scaling down to specifications. Where failure occurs in long (Euler) columns the ultimate strength is a function of the modulus of elasticity and is not influenced by ultimate tensile or yield point values. Accepted theory also recognizes the modulus of elasticity as the only property that governs local failure, although tests indicate that other properties do influence the value somewhat. Since the modulus of elasticity is closely constant for all steel, no correction is called for where failures are of long columns or in local buckling.

Since the strength of thin shells and other structures made up of thin metal is controlled almost entirely by the modulus of elasticity, it is evident that alloy steels and heat treating have little place in thin metal structures as regards their structural strength (except where pure tension can be shown to exist) and their stainless properties, weldability or possibly some particular draw characteristics are their only advantages over cheaper steels.

Deflection—Up to this point the discussion has been limited to the determination of ultimate strength and yield point. Rigidity is sometimes of greater importance than strength and testing is an ideal means of obtaining deflection characteristics of a part. The strength determinations of some structures are determinate and easily calculated. All deflection calculations are precise in that they consider section and material properties in their solution. Hence they are complex and laborious.

Test More Costly but More Accurate

Relative Cost—No direct comparison between the cost of a stress analysis and the cost of a test is available. The importance of the solution, the accuracy required or the saving possible from accuracy in the solution are controlling factors. Calculation requires only the services of a competent engineer. Testing involves the cost of the test specimen and of test jigs as well. Certain equipment must be available and the set-up made, the test conducted, and the results plotted, interpreted and reported. As the analysis problem becomes more complex, the increment of cost between test and analysis becomes less. Frequently the requirements are such that analysis cannot meet them under any condition. Testing has its definite place and the cost involved is further offset by the display advantage which was suggested in the introduction. Testing can replace analysis; testing of arbitrary sections can provide basic analysis data; tests can supplement an analysis by demonstrating the strength at points beyond the scope of the analysis; tests check the analysis and furnish useful data for subsequent analyses.

Testing equipment need not be elaborate. Almost all that is necessary for a satisfactory test can be obtained in any shop and drafting room. In subsequent articles, actual examples of the influence of testing on design, as well as simple test procedures and results will be given as a guide to designers who find it desirable to obtain facts concerning the strengths of the particular machines in which they are interested.

Scanning THE FIELD FOR Ideas

EARLY builders of high pressure hydraulic machinery, hydraulic presses in particular, frequently encountered difficulties due to porosity of the oldtime castings. At peak pressures liquid would appear on the outside surfaces, especially of cylinder castings, attended by a distinct loss of pressure within the system.

In seeking a way to salvage such machined parts, it eventually was discovered that seepage could be stopped by heating them and treating their bores with a bath of melted "rosin," as the familiar pine tree product used to be called. This material had the faculty of penetrating the metal sufficiently to seal it against seepage of water.

While modern castings in several varieties of alloys will hold high pressure liquids or gases without leaking, there sometimes are cases where corrosion resistance, or shrinkage and other manufacturing considerations, demand that the designer specify metal of lesser density. To render such castings pressure-tight, General Plastics, Inc., has recently developed a solution of specially formulated synthetic resin. Pressure castings inclined to be slightly porous are impregnated with this solution by pressure, or by vacuum and pressure. They then are baked at a minimum of 250 degrees Fahr. which sets the synthetic resin so that it not only withstands water but also solvents, mild alkalies and acids.

Whirling Blades Shear by Impact

SOMETHING decidedly out of the ordinary both in design and in action is the electrically driven dry shaver shown diagrammatically by *Fig.* 1. This shaver, which is of rotary type and in appearance somewhat resembles a salt shaker, has been developed during the past two years by F. E. Moskovics, well known mechanical engineer and former president of the Stutz Motor Car Co.

The mechanism embodies a rotary head mounted directly on the end of a motor shaft. This rotary head is a flywheel whose spherical top contains four radial slots. The outer ends of these slots incline upward from the horizontal. As they whirl, four flat steel blades in these slots tend to "climb" the inclines, and bearing against the inclines as they do at a point below their centers of gravity, they also tend to revolve upward about the point of contact. The effect of these combined actions is to lift and hold the blades in firm sliding contact with the inner surface of the spherically crowned and slightly resilient perforated cap which is the "shaving end."

This cap, which is quickly interchangeable with a slotted depilator head, is of finely tempered steel .003-inch in thickness and pierced with approximately nine hundred .020-inch holes. This relation of metal thickness to hole diameter has been found to insure close shearing of hairs without skin abrasion. As the smooth crowned surface of the perforated plate is passed over the face, attending light pressure

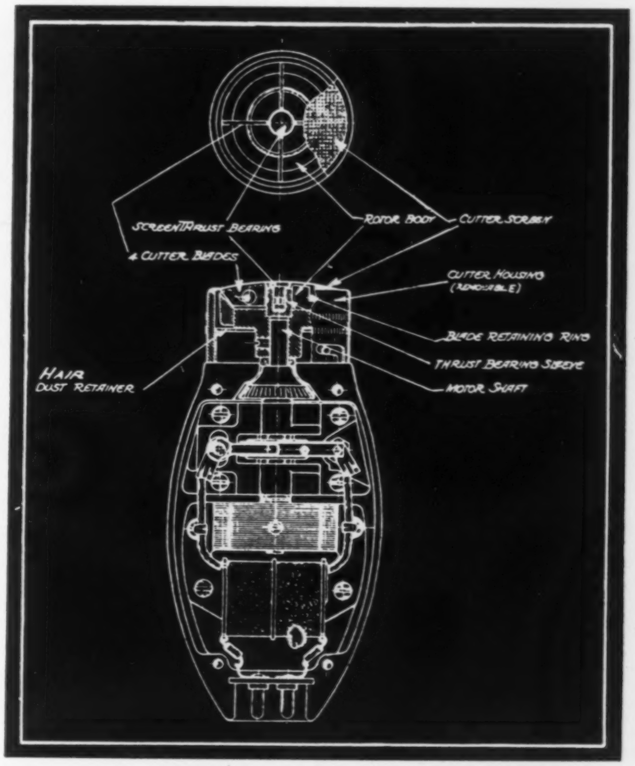


Fig. 1—Blades of dry shaver are spun against perforated steel disk by high speed, slotted flywheel

extrudes hairs from their follicles as they enter the apertures. The result is that they are cut off at—or even slightly below—the normal surface of the skin.

The whirling blades engage each hair aperture 28,000 times per minute and shearing effect is due to velocity of impact. A space of .020-inch between the inner face of the cap and the top surface of the "flywheel" carrying the cutters, allows air currents to assist centrifugal force in throwing severed hairs into a retaining chamber.

The body of the shaver is of molded plastic, shaped to fit the hand and at the same time neatly to house the relatively large and powerful motor. This motor, which is started by means of a serrated "thumb wheel" on its shaft, utilizes contacts shunted by a condenser, which are comparable to the breaker points on an automobile. Self-lubricating bearings are used throughout.

Supercharges Standard Motors

ONE of the significant things which has been, as one might say, "handed down" from the aircraft industry to the automobile industry, is the supercharger. Developed originally to insure normal operation of aircraft engines in the rarified atmosphere of high altitudes, this device has now become recognized as an effective means of stepping up the power of automobile engines operating at ordinary ground levels.

Such a means for the "forced feeding" of air to an automobile engine is that depicted by *Fig.* 2, below. This inexpensive centrifugal-type supercharger, which is a product of the McCullock Engineering Co., is designed for installation in connection with Ford V-8 engines used in vehicles or on marine motors and industrial power units. As indicated by the illustration, the unit is designed for installation between carburetor and intake without requiring changes in the basic engineering of the motor itself.

It will be noted that to transmit the additional power required to drive the blower, triple V-belts with a spring-tensioned idler have been substituted for the single belt ordinarily used to drive pumps, fan and generator. Also, the generator has been relocated to one side to make room for the right angle drive for the blower.

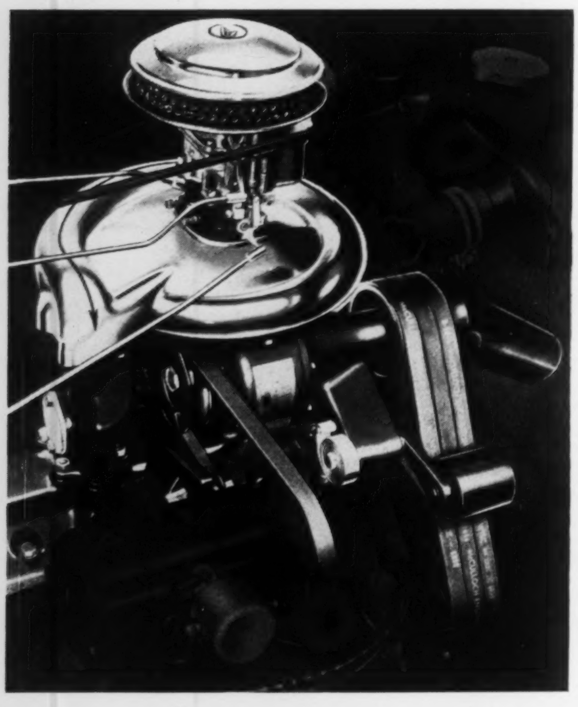


Fig. 2—Supercharger is designed for application to standard engines without requiring basic changes

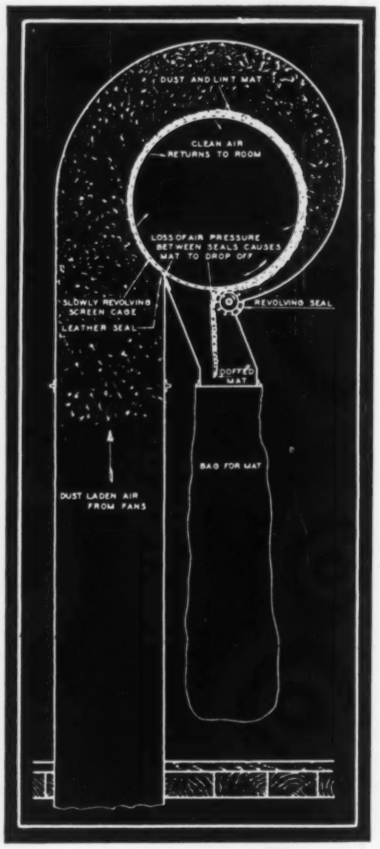

DUST AND LINT MAT
CLEAN AIR RETURNS TO ROOM
LOSS OF AIR PRESSURE BETWEEN SEALS CAUSES MAT TO DROP OFF
SLOWLY REVOLVING SCREEN CAGE
REVOLVING SEAL
LEATHER SEAL
DOFFED MAT
BAG FOR MAT
DUST LADEN AIR FROM FANS

Fig. 3 — Dust-ladened air from pickers is cleaned by passing through a revolving screen which automatically discharges mat of lint into bag, while cleaned air returns direct to picker room without loss of heat

According to the maker of this supercharger, tests at normal levels show increase in engine power from the rated 85, to as high as 124 horsepower, along with saving in fuel consumption and smooth performance. Where the engines must operate at high altitudes, the unit is said not only to eliminate the usual power loss common to those conditions, but actually to step up the power to as much as 38 per cent above normal sea level performance of the same engine with ordinary suction air intake.

Dust Removed but Heat Is Saved

DUST and lint thrown into the air of the picker room of a textile mill involve serious health and fire hazards, as well as costly heat losses if the dust-ladened air is discharged out-of-doors. Shown in *Fig.* 3, above, is an air-cleaning system designed

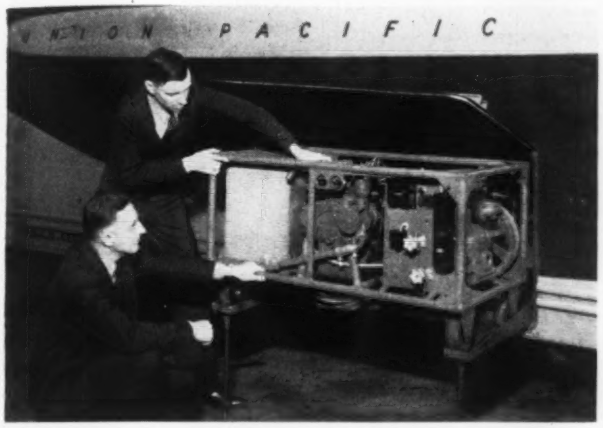


Fig. 4—Bus air conditioning unit rolls out on rubber-tired wheels for convenience in servicing

to remove dirt from picker room air without wasting this warmed air. This was developed by Knowlton & Newton Co. Inc., built by Whitin Machine Works.

Each picker fan exhausts approximately 1500 cubic feet of air per minute, which means 22,500 feet per minute from a room containing fifteen fans. The purpose of this return air condenser is to filter dust from the air delivered by the picker fans, to collect the debris in a bag and to return the cleaned warm air directly to the room from which it was drawn.

Dust-ladened air from the pickers is blown directly into the "cyclonic" condenser, the operation of which is entirely automatic. This is a self-contained unit, 6 feet long, 5 feet wide and 6 feet high which can be suspended from the ceiling or can stand on the floor. It takes care of any number of fans to nine.

A cylindrical screen is revolved continuously in the cyclonic head by a ⅛-horsepower motor. The air filters inward through the screen, and as the screen revolves, a mat of debris grows thicker and thicker on its periphery until it reaches the revolving seal. Having passed this seal, the mat is blown off and coils down into a burlap bag which is emptied only once every three or four days.

Compact Units Cool Buses

THE world's first fleet of air conditioned buses has just gone into regular service from Chicago and Kansas City to the Pacific coast. These 140 buses, operated by the Interstate Transit Lines (Chicago & North Western Stages and Union Pacific Stages) are equipped for year around conditioning, in a manner similar to that employed in modern buildings.

The compactness and accessibility of the Baker unit is clear from *Fig.* 4. Design is such that this unit, which is housed in the lower center of the bus body, can be rolled out on rails for inspection and servicing, or for quick replacement. It is mounted on rubber-tired wheels to soften road shocks.

The frame, which is welded aircraft tubing, carries a motor-compressor complete with self-starter, governor and generator linked by multiple V-belts. The generator drives the condenser fan and pump motor as well as the engine radiator fan. Two air filters are employed, one removing dust, dirt and pollen; the other removing odors. Air is dehumidified as well as cleaned and cooled in summer, and is heated during the winter.

Air is diffused into the bus through perforations in a "false roof" and is removed through vents at the floor. There is a complete change every three minutes, thermostat control keeping inside temperature 15-degrees below outside during hot weather. Control is from the driver's master control station, visible and audible signals indicating the functioning.

Prongs Provide Automatic Contact

UNIQUE in several respects, the electrically heated iron shown in *Fig.* 5 is characterized as "cordless." This appliance, which is made by the Electrical Products Co. is shown on its safety base in the upper view, while the lower view shows the base alone.

While the heating elements are within the iron, they are connected to the electrical circuit only when the iron is resting on its base. This is accomplished through prongs under the rear support of the handle. These automatically engage contacts in the slots at the rear of the base when the iron is set down. Behind these contact slots is the heat control which is set for ironing various materials, by turning the knob on the top.

The button toward the front of the base is the thermostat, which measures temperature of the actual ironing surfaces, rather than of the interior.

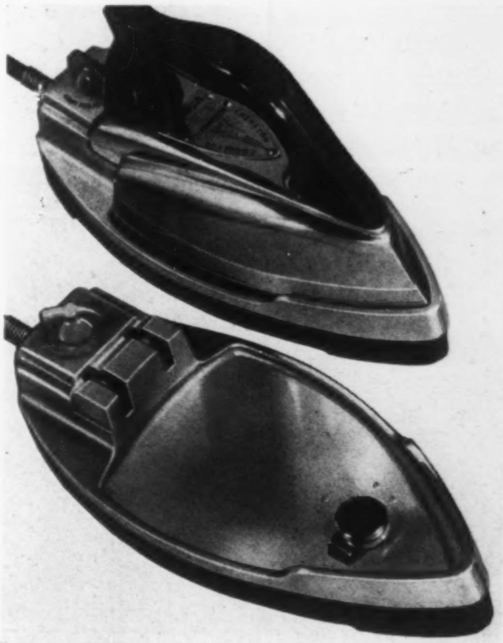


Fig. 5—Cordless iron is heated while on its base, by current delivered through prongs

Don't Risk Failure of Machine Through Bearing Trouble!

JUST as a chain is no stronger than its weakest link, so also can it be said that no machine is more dependable than its least dependable bearing. While it is true that many factors contribute to the excellence of modern machinery, especially that of high speed and heavy duty type, no single factor has been any more influential than the improvement in bearings—both plain and antifriction.

This article deals with large bearings and with those subject to unusually heavy loads. Looking back to heavy machinery of not so many years ago, the thought of such bearings recalls the odor of dangerously hot lubricant; oozing and flying grease; knocking and pounding due to looseness; and all too frequent shutdowns for refitting or replacement. It would be interesting to know how many of the mechanical developments such as the steamship GREAT EASTERN which were "too far ahead of their times," really were too far ahead of bearing developments.

Just so long as responsibility for the design of all the bearings in a machine rested entirely upon the engineering department of the individual machinery builder, there always was a chance that some indifferent bearings would get into a machine. While factory tests did eliminate any downright bad installations, the indifferent ones would not show up until the machine had been in operation in the customer's plant for a considerable period. While it is true that many very excellent bearings have been designed by machinery builders, there have been too many indifferent ones, and by the same token too many dissatisfied customers.

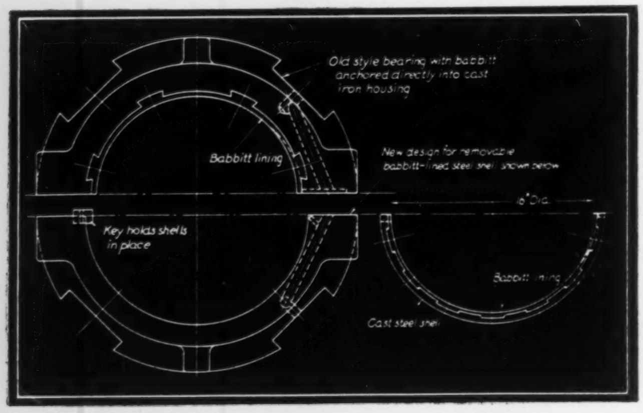

Old style bearing with babbitt anchored directly into cast iron housing
Babbitt lining
New design for removable babbitt-lined steel shell shown below
16" Dia.
Key holds shells in place
Babbitt lining
Cast steel shell

Fig. 1—Babbitt-lined cast iron housing (upper) is now replaced by removable linertype in lower views

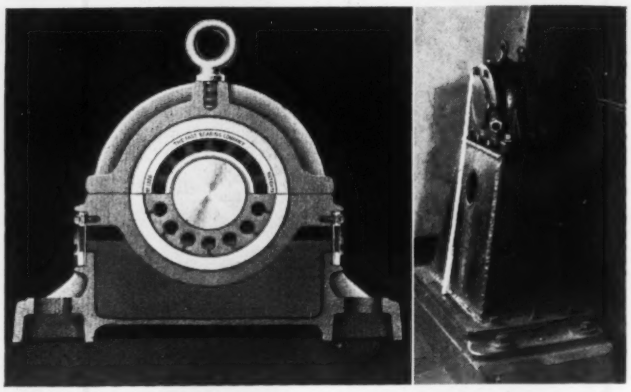


Fig. 2—Bearing of power station blower runs on oil film maintained centrifugally, as shown at left

Progressive machinery builders have welcomed the rise of the bearings industry, which has made it possible for them confidently to shift the responsibility for difficult bearing design to the shoulders of specialists who are at the same time able to supply to machinery builders properly designed and carefully manufactured bearings at prices which often-times are below the machinery builders' own manufacturing costs for bearings of doubtful quality.

Most readers of this article probably are aware that this shift of responsibility has been quite general among users of the more common types of standard bearings such as are used in huge quantities in the automobile industry. Some of them may not be aware however that bearing manufacturers today are likewise assuming the responsibility for the design and manufacture of many very large, and heavy duty and highly specialized types of bearings of which only a few—perhaps only one or two pairs—will be used, as for instance on lock gates or on a large generator. The fact that in some cases these large bearings, the lower one in *Fig.* 1 for instance, have been designed as replacements, indicates the advisability of having specialists in bearing design and manufacture "in on" the original design, thereby avoiding to a large extent

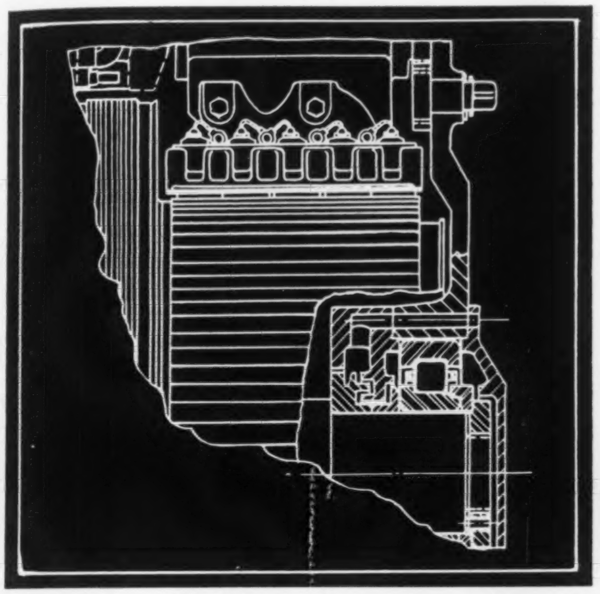


Fig. 3—Cylindrical roller bearing application to 625-horsepower motor of an electric locomotive

the serious embarrassment of premature replacements.

In the case depicted by *Fig.* 1, the bearing supports a heavily loaded pinion shaft, which is 16-inches in diameter. The original design, shown as the upper half of the split bearing, had its babbitt lining applied direct to the cast iron housing. Since babbitt does not bond well to cast iron, deep anchor grooves had to be provided and babbitt thickness of ⅜-inch was required. However, the primary reason for the redesign, shown in the two lower views, was the difficulty of rebabbitting this big bearing "on the job."

In the new construction, as the drawing clearly shows, the babbitt is applied to semi-cylindrical cast steel shells held in place in the split housing by a key. These cast steel shells—to which babbitt bonds much better than to cast iron—are readily and quickly replaced by another pair in the event of undue wear. The worn ones can then be returned to the factory, where a first class rebabbitting job is assured.

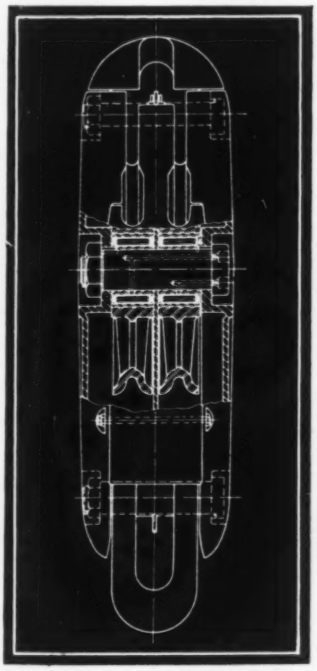


Fig. 4—This oil well tubing block, which weighs 1000 pounds, has roller bearing sheaves with capacity of 30-tons each allowing three-to-one safety factor

Since the notable researches of Beauchamp Tower, made more than half a century ago, the importance of properly designed means for lubrication have been recognized as being of paramount importance in the performance of sliding bearings. An example of engineering for effective lubrication is shown in *Fig.* 2.

As shown in the view at the left, the load is carried on a pressure oil film maintained by centrifugal force as the integral blocks revolve in the oil bath in their sealed housing. In a manner which is comparable in a way to that of the shoes of a Kingsbury thrust bearing, these integral blocks have a tendency to tilt slightly, forming wedge-shaped multiple oil films of great load-carrying capacity. At the right is shown one of the bearings installed on a fan blower.

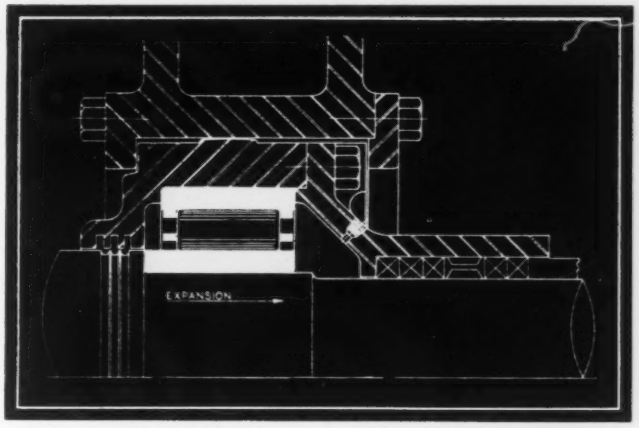


Fig. 5—High-load type solid roller bearing as applied to the tending end of paper machine dryer roll

A manufacturer of sump pumps recently adopted bushings made from a composition of powdered nonabrasive minerals, bonded with an insoluble material and molded to size under heat and pressure. These bushings, which can be lubricated with water as well as oil, have now run for several months without appreciable wear. Similar bushings, containing a percentage of atomized lead, are operating successfully in an oven at 375-degrees Fahr., without lubrication.

An interesting application to which cylindrical roller bearings have been applied is that shown by *Fig.* 3. This reveals the mounting of the commutator end of the armature shaft of a 625-horsepower electric locomotive motor. This is a lipped roller bearing with separable inner ring—endwise float being taken care of by means of the roller bearing at the pinion end, the latter having a straight cylindrical inner raceway. These bearings are subjected to tremendous loads in starting, even though there is a spring gear arrangement in the drive to absorb some of the

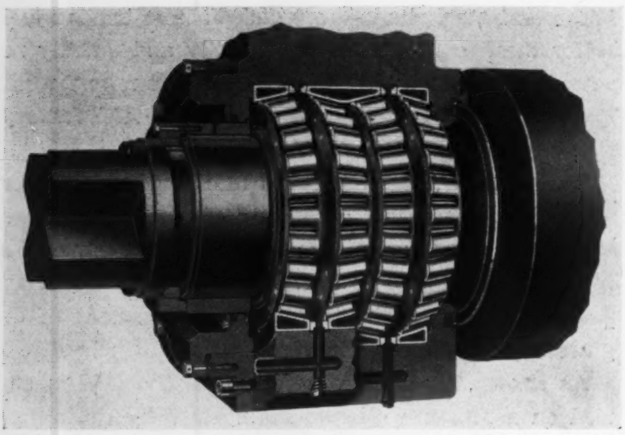


Fig. 6—Four row tapered roller bearing assembly designed for necks of rolls in steel mill service

shock load. They are of approximately 6-inch bore and rotate up to 1400 revolutions per minute. Note the care taken to protect the bearing and retain grease.

The oil well tubing block, one shown by the drawing, *Fig.* 4 and designed by the Baash-Ross Tool Co., weighs 1000 pounds. It has capacity of 30 tons per sheave with safety factory of three-to-one based on yield point of the steel. The solid cylindrical roller bearings of the sheaves have cages with form-rolled spacer bars which allow use of the greatest possible number of rollers per bearing.

Application of a solid roller bearing of high load-carrying capacity to the tending end of a paper machine dryer roller, is the subject of *Fig.* 5. This case presented a number of unusual problems, the most critical being the necessity of providing for axial movement of the journal due to expansion of the roll. The housing has been made self-aligning and this type of straight cylindrical type of bearing permits the axial movement—the inner race being shrunk on the journal and slightly offset to keep the roller-operating area well away from the end of the race.

One of the "tough spots" wherein the application of heavy duty antifriction bearings has lately come to be recognized as desirable standard practice is in the steel mill. Rolling mill service demands bearings which not only will stand up under rough service under working conditions which are a real test for stamina, but also which will hold close accuracy. A roll neck application which is working out successfully is that illustrated by *Fig.* 6, this involving four rows of tapered roller bearings at each end of a roll.

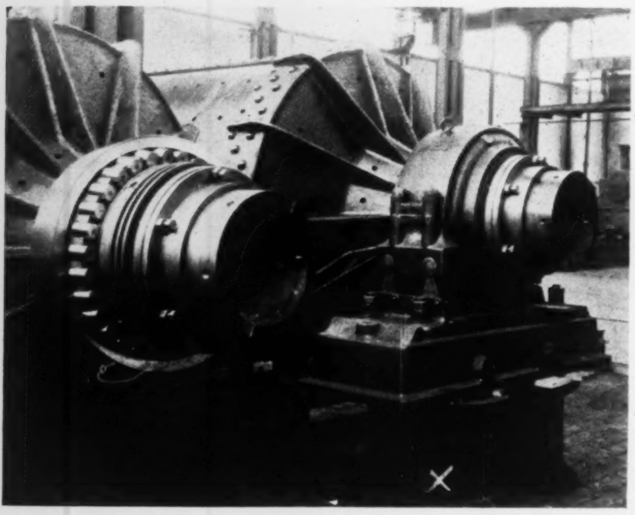


Fig. 7—Manner in which self-aligning spherical roller bearings are adapted to a ball and tube mill

Application of roller bearings to ball and tube mills involve the handling of extremely heavy loads and compensation for serious conditions of misalignment. The mill which is depicted in the course of erection in *Fig.* 7, is of the type having a hollow trunnion surrounded by a spherical roller bearing. The bearing at one end is held axially, while that at the opposite end is mounted to allow endwise movement for expansion.

To get an idea of the great size to which antifriction bearing installations are running these days, consider *Fig.* 8. This photograph shows two of the pillow blocks installed recently on a vertical lift bridge in Chicago, which is 276-feet long, weighs 3,220,000 pounds and lifts 104 feet. Four of these pillow blocks are used at each end. Each of them, together with their straight roller type bearings, weigh 22,500 pounds. The outside of the outer race is ground spherical to match the ground spherical bore of the pillow block—thus providing for self-alignment.

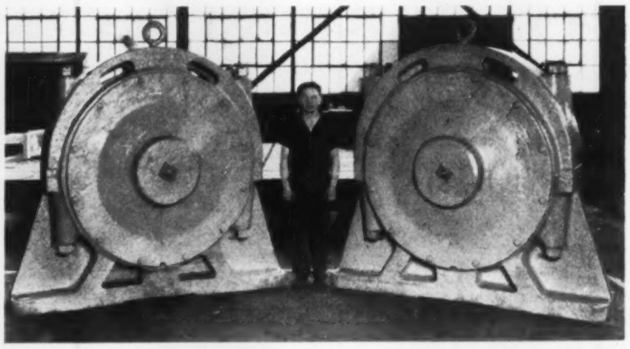


Fig. 8—Eight of these huge roller bearing pillow blocks are used on a 276-foot vertical lift bridge

In the course of preparation of this article a number of individuals and companies have gone to considerable trouble to furnish useful information and interesting illustrations. MACHINE DESIGN therefore takes this opportunity to express its thanks to the following for such co-operation: Bantam Bearings Corp. (*Fig.* 8); The Fafnir Bearing Co. (*Fig.* 4); The Fast Bearing Co. (*Fig.* 2); Federal-Mogul Corp. (*Fig.* 1); Hyatt Bearings division, General Motors Corp. (*Fig.* 5); Lumen Bearing Co.; Norma-Hoffman Bearings Corp. (*Fig.* 3); Joseph T. Ryerson & Son Inc.; SKF Industries Inc. (*Fig.* 7); The Timken Roller Bearing Co. (*Fig.* 6); and Wellman Bronze & Aluminum Co.

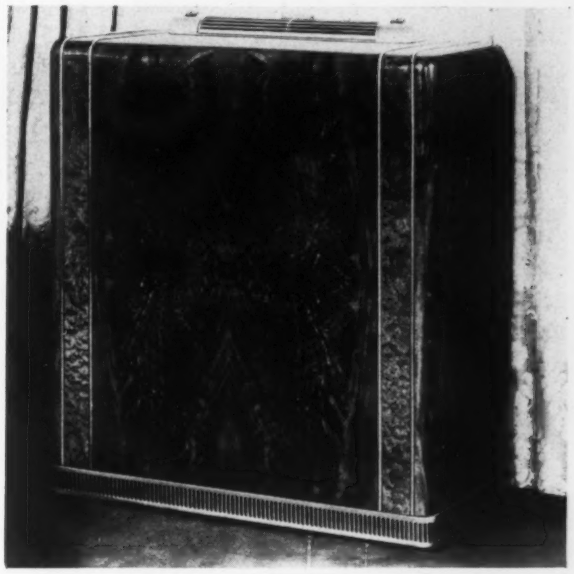


Fig. 1—Casing of air conditioner is finished in wood grain finish. Grain design is transferred by heavy rollers, then baked to give hardness

Air Conditioner Is Study in Compactness, Quietness

By J. H. Vogel
York Ice Machinery Corp.

SEVERAL important design considerations confront the engineer in the development of an air conditioning mechanism, especially so since these units have been introduced into the home and office. Fortunately refrigerating apparatus, which is the nucleus of most small air conditioning systems, has been refined for household use until it is a smooth, quietly functioning, foolproof mechanism, but for air conditioning service this refinement must be advanced another step. To add to design difficulties, other mechanisms are necessary to cool, dehumidify, filter, ventilate and circulate the air and in the small portable model a minimum of space is available.

Of supreme importance is quietness. The machine must be designed and built to run without the slightest noise. Naturally it must require a minimum of lubrication and servicing. Extra precaution must be taken to eliminate any chance of leakage of the refrigerant. Ammonia was the most commonly used gas when refrigeration was for

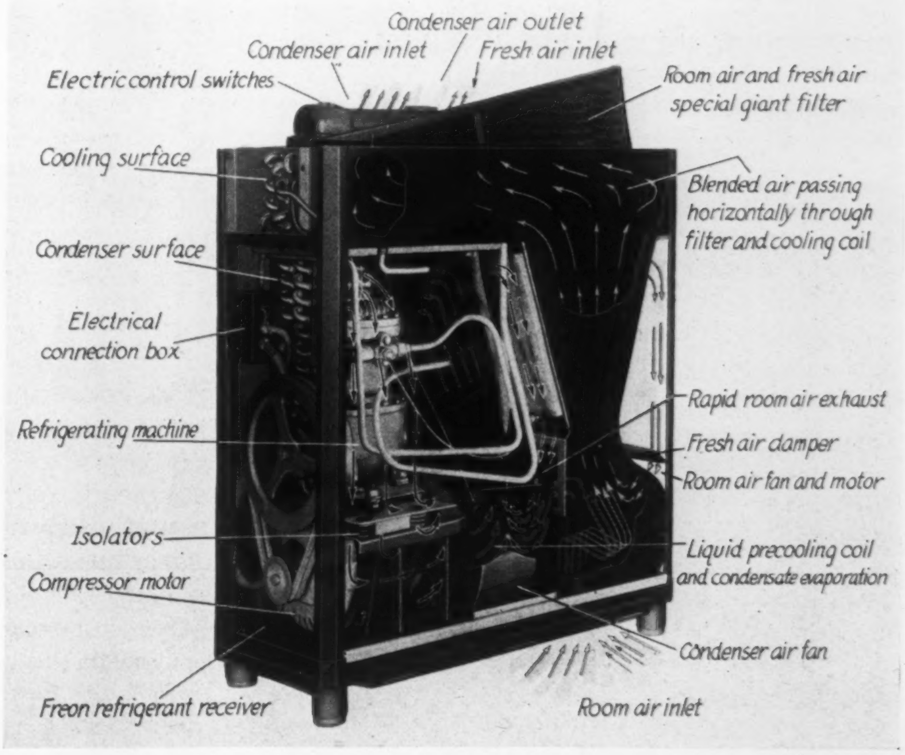

Condenser air outlet
Condenser air inlet
Fresh air inlet
Electric control switches
Room air and fresh air special giant filter
Cooling surface
Blended air passing horizontally through filter and cooling coil
Condenser surface
Electrical connection box
Rapid room air exhaust
Refrigerating machine
Fresh air damper
Room air fan and motor
Isolators
Liquid precooling coil and condensate evaporation
Compressor motor
Condenser air fan
Freon refrigerant receiver
Room air inlet

Fig. 2—Direction of air flow and various parts contained in machine are shown Air conditioner occupies 4.3 square feet of floor

most nearly perfect refrigerant ever developed. The usual problems of obtaining compactness and pleasing appearance are of prime importance in a machine of this type.

The current model of the Yorkaire portable air conditioner, manufactured by the York Ice Machinery Corp. is an excellent example of correctly applied design. *Fig.* 1 shows the finished machine. In beauty, operation and efficiency the machine excels in its field. The unit occupies 4.3 square feet of floor space and weighs 500 pounds. Basic design of this machine was conceived five years ago but the present model includes many new features and design innovations which make it outstanding.

A discussion of this portable air conditioner begins logically with the compressor which is the heart of the unit. It is the function of this machine to compress the refrigerant vapor and discharge it into the condensing coil, where the gas may be condensed to a liquid, after which it is again expanded in the evaporating coils. *Fig.* 6 depicts the twin-cylinder compressor and the method of design which allows it to be easily disassembled.

Enclosed crankcase of the compressor is cast electric furnace nickel iron. Fins are cast on exterior of cylinder walls for cooling. Inside shape of the crankcase was actually developed through tests to allow minimum friction or resistance of the lubricating oil to rotating parts. Shape of the interior of casting causes rotating parts to give a gentle surge through the oil rather than a splash; curved bottom of crankcase permits easy and complete draining of the oil. Level of oil in the crankcase is above the crankshaft and main bearings, aiding the seal ring in preventing loss of the refrigerant. Metal gaskets are used throughout the compressor to resist deterioration.

In the reciprocating assembly, *Fig.* 4, there are several interesting features such as the full floating piston pins, common in light engine construction. Ends of the pins are fitted with copper tips which prevent scoring of the cylinder walls. Close tolerances in this compressor make unnecessary the "springing" of any parts in assembly. Extreme accuracy of the crankshaft to size, taper and roundness, results in quiet operation, small friction loss and long life of the equipment. On top of the connecting rod is a funnel-shaped opening to catch the oil that drops from the inverted cone-shaped dome in the guide or lower part of the piston (See *Fig.* 5). Purity of the oil so introduced into the pin bearings is assured by the simple method of atomizing and collecting on the piston dome from where it drops into the funnel-shaped opening of the connecting rod.

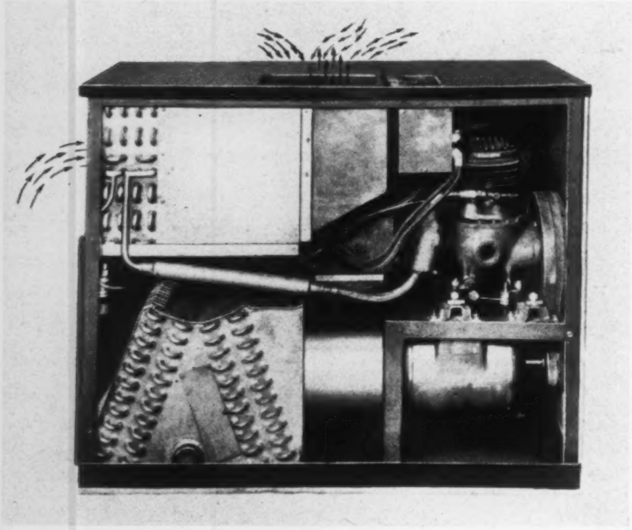


Fig. 3—Older model of air conditioner did not permit the precise control of air temperature and humidity that latest model does

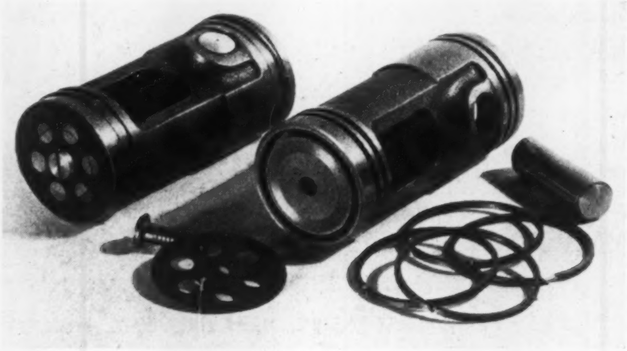


Fig. 4—Thin steel disks mounted on top of pistons and in cylinder head are used for both suction and discharge valves

"Pressureflex" valve disks, made of Swedish steel, are used for both suction and discharge valves (See *Fig.* 4). They are of the full opening type, easily changed in case of repair. Holes are provided in the valve disks for greater effective valve area which reduces the amount of flexing or lift required of the valve. Valve seats are formed by machining the top bearing surface to provide a narrow circular area or seat on each side of the gas passage holes. These ground and lapped surfaces provide an effective means of sealing the valves. The valve disks are bolted to the steel discharge valve plates and pistons. The plate assembly is located in the top of the cylinder by two locating pins.

The complete assembly of crankshaft, connecting rods and pistons complete with rings, piston pins, and suction valves can all be assembled and then inserted as one part into the crankcase.

A unique feature of the compressor is the "Balanseal" shaft seal, a steel diaphragm which utilizes crankcase pressure to maintain a constant tension against the sealing surface around the crankshaft. No spring or metallic bellows are necessary.

For adequate lubrication of the thrust bearing area the centrifugal force of the revolving crankshaft only large applications, but today we find a non-toxic and non-irritant gas, Freon 12, usually employed. This is not dangerous to humans and is considered the is utilized. Hole through the closed bearing end of the shaft communicates with a half hole in the cheek of the shaft which in turn touches the flange or thrust end of the main bearing. A specially designed reservoir is cast with the crankcase at the rear of the closed end of the bearing. The oil is drawn from the reservoir into a tube drilled through the center of the crankshaft; the center tube connects with a half round hole located on the face of the shaft shoulder. The half round hole extends across the shoulder and touches the thrust shoulder of the closed end bearing. As the shaft rotates, centrifugal force draws the oil through the shaft and out of the half round hole, producing a continuous circulation of oil which lubricates the entire thrust bearing area.

Depicted in *Fig.* 2 is a cutaway view of the entire air conditioning machine. In *Fig.* 3 is an older model of the Yorkaire air conditioner. A comparison of the two machines shows many of the advances which have been made. Arrows show the direction of air travel. Air is drawn into the unit at the lowest point. After passing through the grille at the base of the unit, the return air passes through an opening in the pan behind the room-air fan and is then drawn into the fan chamber and discharged upward through the duct.

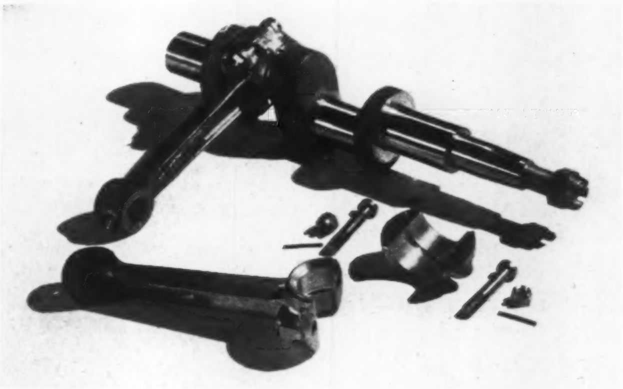


Fig. 5—Wrist pin ends of connecting rods have funnel-shaped hole through which oil enters pin bearings after dripping from dome of piston

Fresh air from outside the building is drawn through one of the four partitioned sections of the window ducts into the chamber at the end of the conditioner. By opening the fresh air control at the top of the unit, outside air is admitted and blended with the room air in the circulating fan chamber. The blended air is discharged upward through the duct into a plenum chamber along the front top section of the conditioner. From the plenum chamber the mixture of room air and fresh air passes through a filter, through the cooling coils into a second plenum chamber and is then discharged through the rotary grill and diffused throughout the room.

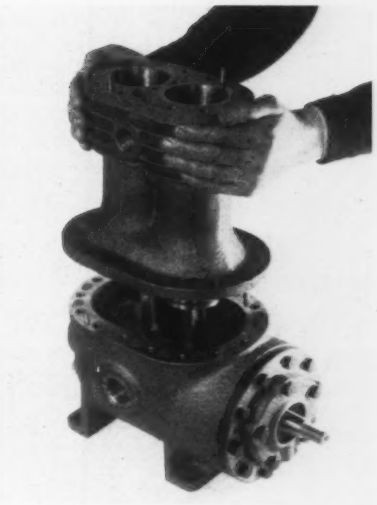


Fig. 6—Compressor is cast of nickel iron and is assembled by merely bolting cylinder unit to crankcase. Cooling fins are cast integral with cylinders

Important feature of the unit is the rapid room-air exhaust or room pump-out. It is operated by closing the control shutter in the top of the rotary grille. Rotating this shutter opens the damper in the side of the room-air fan chamber and closes the room-air discharge duct. Room-air is then drawn through the base of the unit and discharged through the condenser to the outdoors. If the condenser fan is operated during the time the rapid room-air exhaust damper is open, it increases the quantity of air which is drawn from the room. *Fig.* 2 shows how the condenser air travels through the unit compartment.

The condenser and cooling coil are constructed of a new type of corrugated copper finned surface bonded with metal to copper tubes. Tubes are staggered on diagonal spacing and have parallel circuits to minimize pressure drop. Closely spaced fins and greater condensing surface give increased capacity to the condensing unit as compared to earlier models.

The condenser fan scroll contains a liquid precooling or liquid sub-cooling coil which cools the refrigerant before it enters the expansion valve, thereby increasing the unit capacity.

Several methods have been adopted to insure the quietest operation possible of the air conditioner mechanism. By locating all heavy equipment in the base of the unit sound level has been tremendously reduced. Designing long ducts between the fan and the air outlet has further diminished unwanted noise and the application of mechanical sound isolation devices such as rubber and springs to moving parts has practically isolated all sound from the unit. Compressor and the ¾-horsepower motor are suspended as one unit by springs and rubber snubbers which give a free-floating effect to the compressor unit assembly. A 1/20-horsepower motor, also resiliently mounted, drives the evaporator fan. The condenser fan is driven by a shaft direct from the compressor

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Fig. 1—Below—System of helical cams through which piston thrust becomes rotary motion

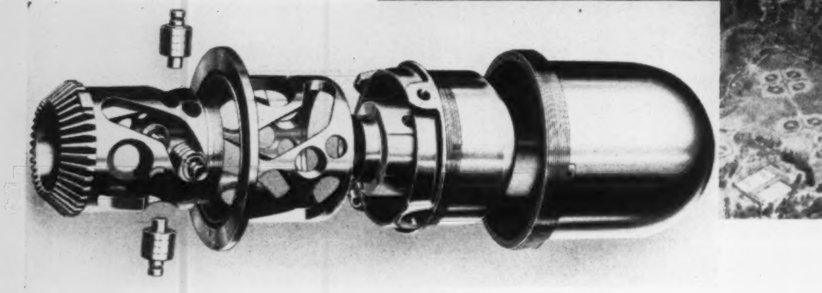
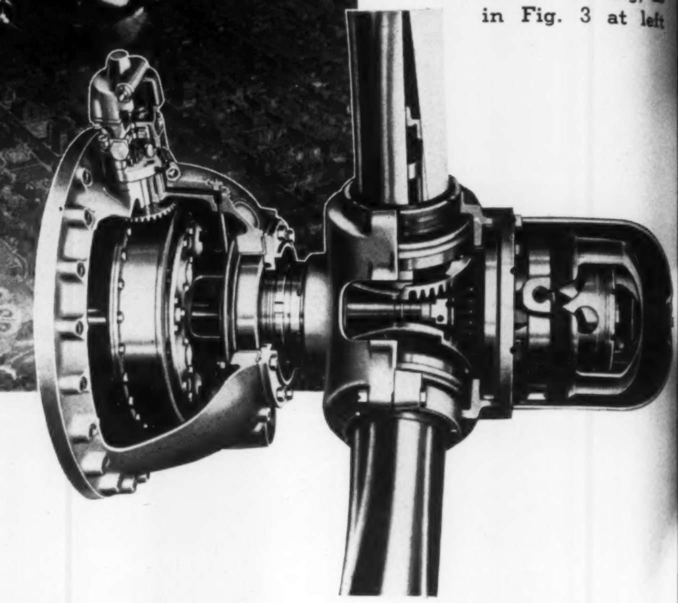


Fig. 2 — Below — Assembly enabling full feathering, as in Fig. 3 at left



Quick-Feathering Propeller

By F. W. Caldwell

Engineering Manager
Hamilton Standard Propellers

TO MEET requirements for greater pitch angle range during normal operation and for full-feathering as in *Fig.* 3, our engineering staff has developed the Hydromatic propeller, shown in section with its constant speed governor in *Fig.* 2.

In this design a collar of plastic material is molded between roller bearing race and fillet of blade-retaining shoulder. This insures perfect seating of mating parts, gives a better stress distribution, and protects the aluminum alloy blade from chafing action. It also permits an oil seal between hub and blade which would not be safe in direct contact with an aluminum alloy blade as it might cause stress concentration. Thus it is possible to maintain fairly high lubricant pressure on all working parts in the hub.

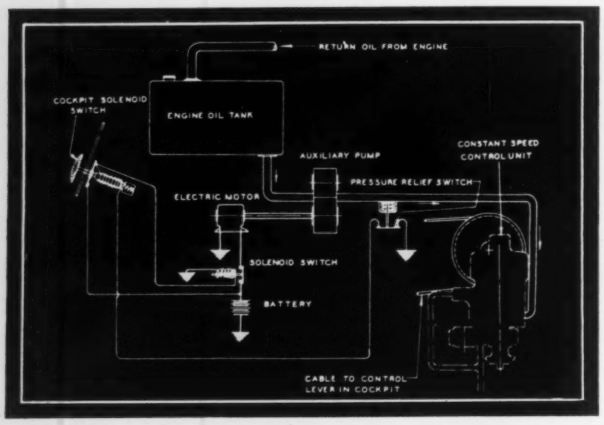


Fig. 4—Typical control setup for handling Hydromatic quick- feathering propeller

Propellers in feathered position will not carry out the normal propulsive function, hence it would be dangerous if they could be feathered unintentionally.

This problem has been solved by taking advantage of the fact that centrifugal force tends to cause the blades to go into low pitch. Engine oil, boosted to higher pressure by the constant speed governor pump, overcomes this centrifugal effect when pitch is to be increased. This pressure acts on a large piston, whose thrust is transformed into rotary motion by cam rollers acting on coaxial helical cams of opposite pitch slope, see *Fig.* 1. For normal pitch range the cam follows a steep helical angle giving the piston high mechanical advantage. When pitch reaches maximum operating valve, the cam becomes flatter and mechanical advantage of the piston is insufficient to overcome centrifugal twisting of the blades when normal operating pressures are used. Thus a maximum pitch limit is provided for normal flight. If considerably increased oil pressure is supplied from some other source under control of the pilot, the piston overcomes blade twisting and pitch is increased to feathered setting.

Engine oil under normal pressure acts constantly on the opposite face of the propeller piston, and as "resilient pressure" opposes any tendency for change to higher pitch. When the constant speed governor valve relieves higher pressure on the other face, this "resilient pressure," together with centrifugal force, moves the blades toward low pitch.

A diagram of a typical control system is presented as *Fig.* 4. The entire feathering operation is accomplished in about 9 seconds.

Fig. 1—Sapphire stones for the jewel mounting of watt-hour meters are selected with care for texture and size

Friction-Free Bearings Invaluable for Precise Mechanisms

BEARINGS for instruments and tiny machine mechanisms are in a category by themselves. Usually with bearing problems, the designer is concerned with the load his bearing will carry; he takes for granted that the bearing will produce little friction. With miniature bearings, which seldom carry an appreciable load, the designer's attention is centered on obtaining the very minimum of friction. Majority of applications are in delicate mechanisms where ease of rotation and long bearing life are of the greatest importance. Whereas, in the case of a motor, its function is to transform energy by producing work, units such as instruments function merely to indicate or measure. Thus the losses in a motor are but a small percentage of the energy passing through it, but the losses in an instrument constitute the entire energy received. As the energy taken by an instrument is dissipated entirely by producing heat, friction or any other force causing a high expenditure of energy must be kept to a minimum.

The entire field of miniature bearings is often referred to as jewel or pin bearings. The term "jewel" does not necessarily mean that the bearings utilize a jewel, although for many applications jewels are the favored type. Other small bearing types are ball bearings, plastics, ordinary bronze or graphited bronze and various plain, sleeve-type metal bearings. This last group is usually found in toys, the cheaper watches and other mechanisms made to last for a comparatively short time and in which no particular effort is expended to reduce friction.

Miniature bearings are used in all types of small

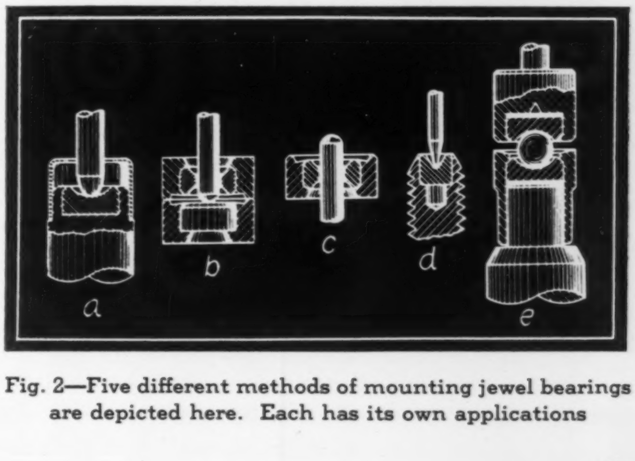


Fig. 2—Five different methods of mounting jewel bearings are depicted here. Each has its own applications

units including tiny motors, meters, recorders, clockworks, weighing devices, etc., in short, whenever it is required to reduce friction to a minimum or space will permit only the smallest of bearings. Miniature bearings are usually considered as those with a hole of 1/32 inch or smaller. Tiny ball bearings made in Switzerland so small that the entire bearing with outer race and balls is less than .036 of an inch in diameter are available in this country. The balls in a bearing of this type (discussed later in the article) may be seen only with a magnifying glass.

Jewels most commonly used are the diamond, sapphire and ruby. The latter two may be either natural stones or synthetic. In recent years the use of synthetic sapphires and rubies has increased to the point where practically all of these two jewels used for bearings are of synthetic origin. The principal arrangements in which jeweled bearings are used are shown in *Fig.* 2. Sketch *a* shows a steel or hard-alloy rounded-end pivot working against a cup jewel. This combination is commonly used for the lower bearing of the moving element of watthour meters.

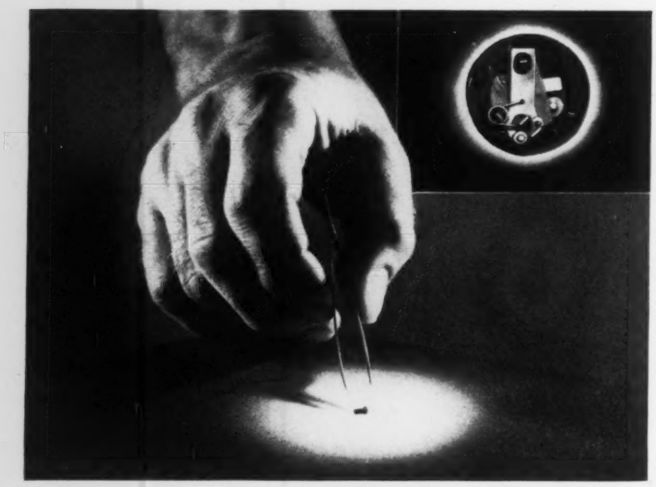


Fig. 3—Tiny bushing of molded plastic serves as bearing mounting in automotive distributor

Fig. 4—Miniature ball bearings, so small they are hardly visible to the naked eye, are available in many different sizes and types

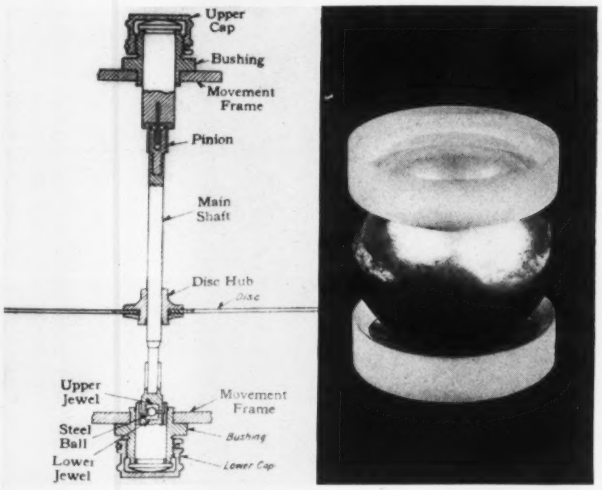
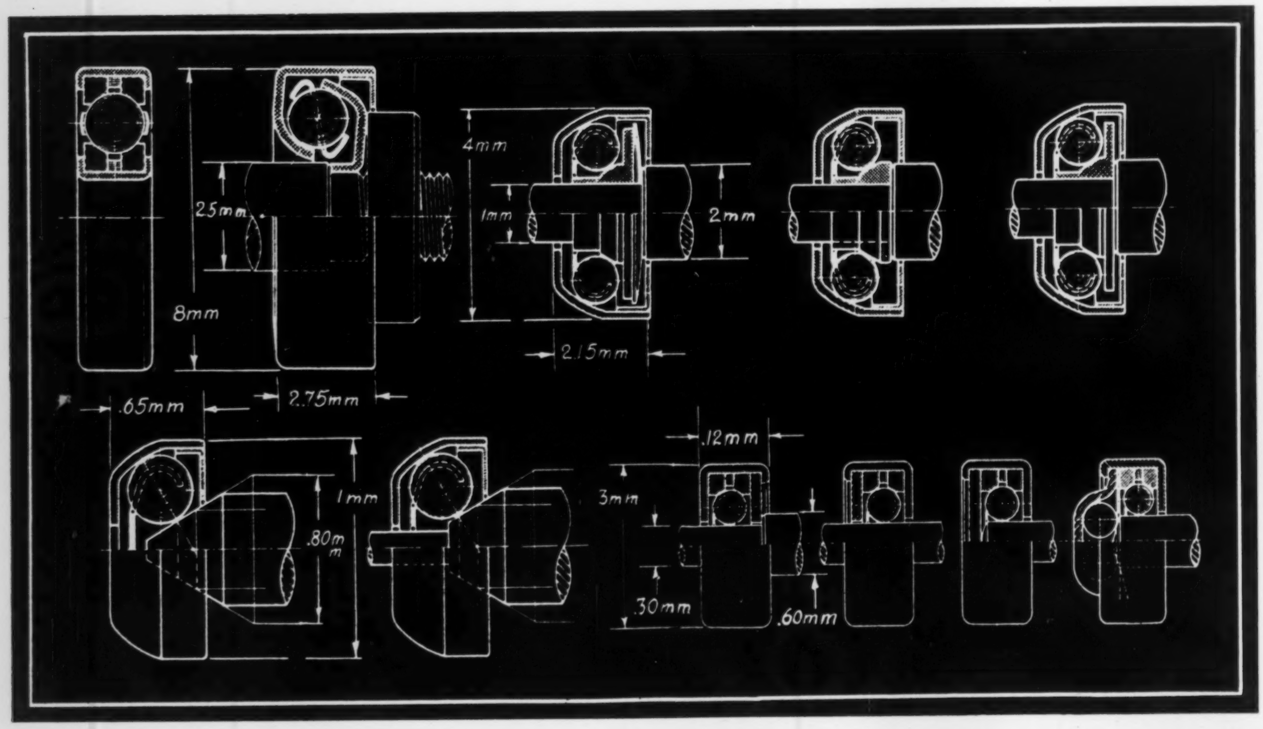


Fig. 5—Rotating element of instrument is mounted as shown in sketch at left. Enlarged view of jewels and steel ball is shown at right

Fig. 2, *b*, depicts the use of a combination of ring or hole jewel with the flat end stone. In this case the pivot is accurately located laterally by the ring jewel and the end stone serves as a thrust bearing. This type of bearing is commonly used in time pieces and other instruments such as electric time switches and chart driving mechanisms. In this bearing the dimen-



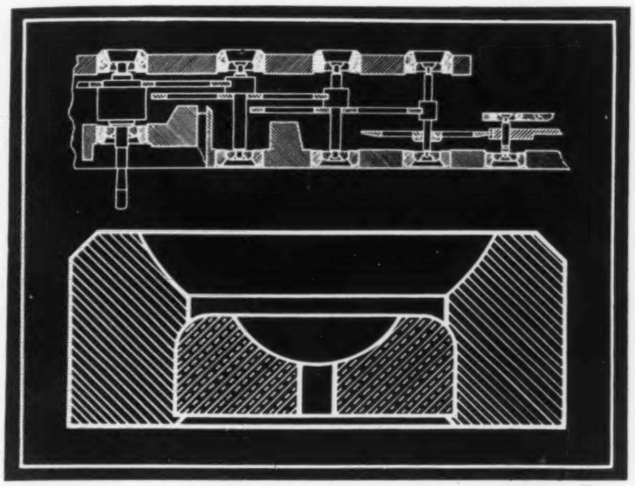


Fig. 6—Profile sketch, top view, illustrates the relative positions of jewels in watch. Enlarged sectional view, below, shows jewel forced friction-tight into setting

sions vary widely; for example, the diameter of the pivot is sometimes as small as .004 inch and in other cases may be as large as .08 inch. The sketch, *c*, shows the use of a pivot operated in connection with a ring jewel but without a thrust bearing. This combination is also used widely in timepieces.

Sketch *d* illustrates the use of a conical jewel, working in combination with a conical pivot. This combination is most frequently used in electrical indicating instruments, but sometimes is applied to timekeeping units. This design results in extremely low friction, at the same time giving accurate location of the pivot with respect to the jeweled bearing. For bearings of this type the jewel is commonly mounted in a screw which permits adjustment for endshake.

A type of bearing also commonly used is shown at *e*. In this design a ball of steel or other suitable material works between two sapphire jewels. One of these is mounted in the moving member and the other in the stationary member of the bearing. Cross section of a Westinghouse watthour meter is shown at the left of *Fig.* 5 and on the right is an enlarged photograph of the steel ball resting between the two jewels. In some cases resilient pads are used to cushion the jewels against possible shock which might result in damage to the highly polished bearing surfaces.

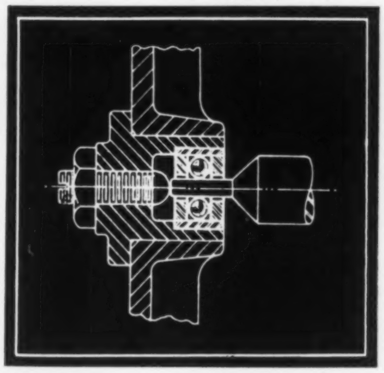


Fig. 7—Adjustment screw, touching end of shaft, is used to take up end play in this miniature bearing mounting

Abrasion is caused in jewel bearings by protrusions which break down by fatigue during rolling or sliding under pressure. The amount of protrusions broken down is the amount of wear. These small particles immediately oxidize to form rouge. The product of wear is a debris, consisting of iron oxide and finely divided particles of sapphire, acting as an abrasive and accentuating the wearing process.

The consequent increase in friction is due to (1) the increased contact area which increases the lever arm of friction torque; (2) the increase in the coefficient of friction, due to the destruction of the polish; and (3) the collection of debris. When a lubricant is used, the life of the pivot is increased almost 30 times. Best lubricants, however, seldom last more than four years. After that time, oil usually becomes resinous or collects enough dirt to make increase in friction objectionable.

Watches, of course, have utilized jewel bearings for centuries and it is in the application of stones to timepieces that much of the development of frictionless bearing surfaces has taken place. Most of the jewels used in watches are synthetic stones and are used in preference to natural stones because of their more even texture and purer composition. They are also more resistant to shock than natural stones and will give lower frictional losses. *Fig.* 6 upper view, shows staffs for different wheels in a watch mounted so that a pivot fits into the hole in the jewel; a shoulder on the staff runs on the flat side of the jewel. Enlarged sectional view in the lower illustration of *Fig.* 6 depicts how jewel is held in setting. The brass or gold blank into which it is inserted has a polygonal hole, slightly smaller than the jewel diameter, causing a tight fit when the stone is pushed into place.

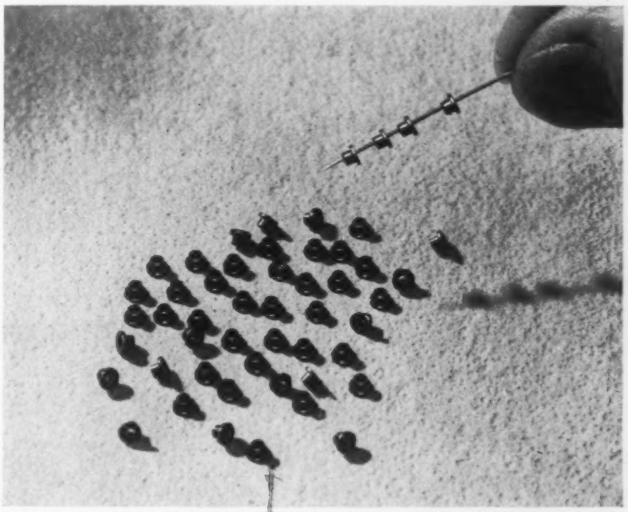


Fig. 8—These tiny bushings are among the smallest ever molded of plastic material. They are used in electrical instruments for supporting jewel bearings

Only one type of miniature bearing causes less fric-

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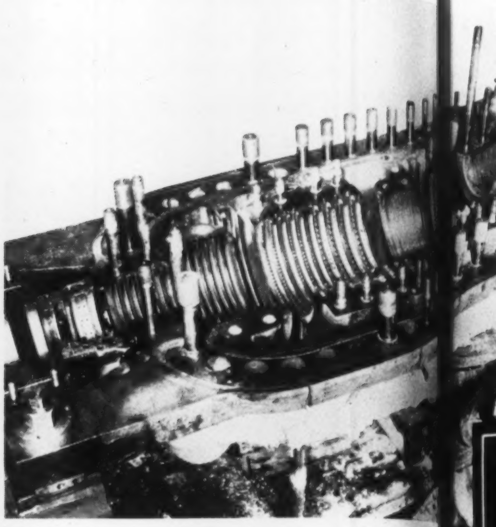
Turbine Design Moves Forward



By C. B. Campbell, Turbine Engineer
Westinghouse Electric & Mfg. Co.

IT IS generally understood that the maximum economical capacity for which a condensing turbine can be built for any particular speed is determined by the limiting physical dimensions of the exhaust and blade, which must pass steam at the very great specific volume corresponding to condenser vacuum without undue leaving losses. At the present time, low pressure blades are available for use at 3600 revolutions per minute corresponding to 26.2 feet^2 of steam passage annulus. One of these blades which is 20-inches long on a 40-inch diameter rotor, has 1250 foot/second blade tip velocity at normal speed.

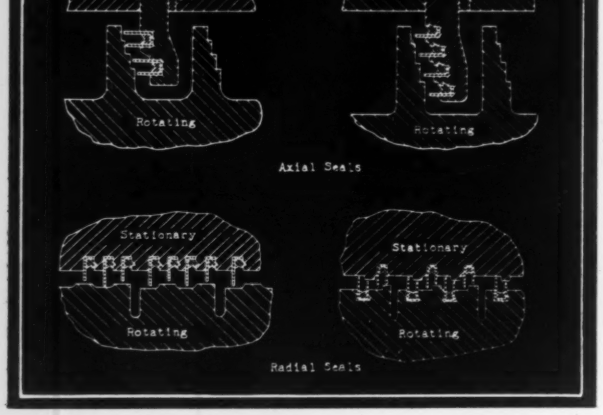


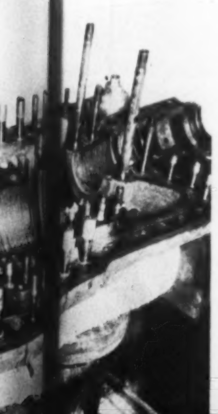
Fig. 1—Radial seals, and axial seals in dummy pistons, are made of rolled stainless steel ribbons

The inlet edge of the blade is shielded with a stellite strip attached by silver solder. This is used as protection against erosion of the blade material by impingement of moisture particles in the steam which do not travel at steam velocity and strike the blade edge at approximately right angles. The rate of erosion is known to vary as the blade speed and inversely as both the density of the surrounding mediums and the hardness of the metal involved. Stellite shielding has been adopted generally for blades exceeding 900 foot/second tip velocity. The stellite strip is three times as hard as the base blade material, and the rate of erosion is approximately one-third that of bare blading.

Details of blade construction, even in the simpler non-condensing, single extraction turbine such as shown in *Fig.* 2, have been improved to meet more exacting demands for reliability, and also because of the necessity of operating at higher temperatures. The 12 per cent chrome blading steel in general use for many years remains satisfactory for the highest temperature encountered. Manganese copper blading is not used above 500-600 degrees Fahr.

Typical reaction blade groups with different sealing details as used in the most recently developed turbines are shown in *Fig.* 3. The blade and its root are integral. For the narrower blades, when used with low temperature and stress, rolled or drawn blade section is cut to length and then brazed to the steel root section, after which the combined piece is machined for the root fastening. The higher stressed and larger blading, however, is machined from bar stock to form the root integral with the blade.

The T-root has superseded the former dovetail root fastening for rotors operating at high temperature, as the dovetail fastening allowed slight lifting of the rotating blade when subjected to repeated heating and cooling. Half-round brass caulking pieces are put



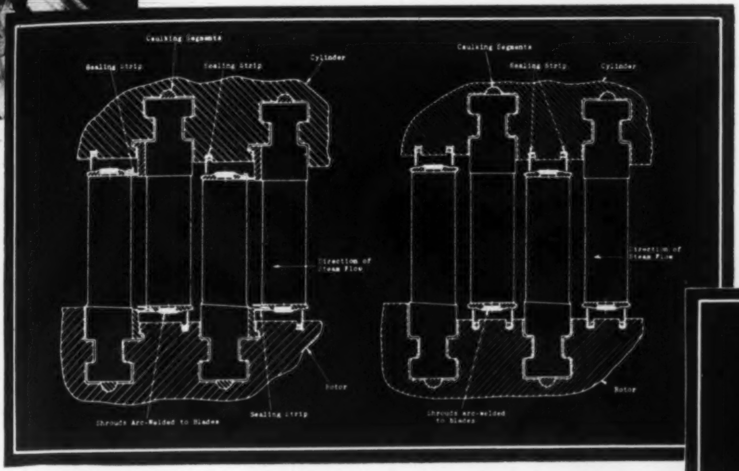


Fig. 2—Left—Cylinder base of relatively simple non-condensing, single extraction turbine, showing reaction blading—Fig. 3—Below—Reaction blade construction of 2-cylinder condensing turbine—Fig. 4—Right, below—High pressure cylinder design

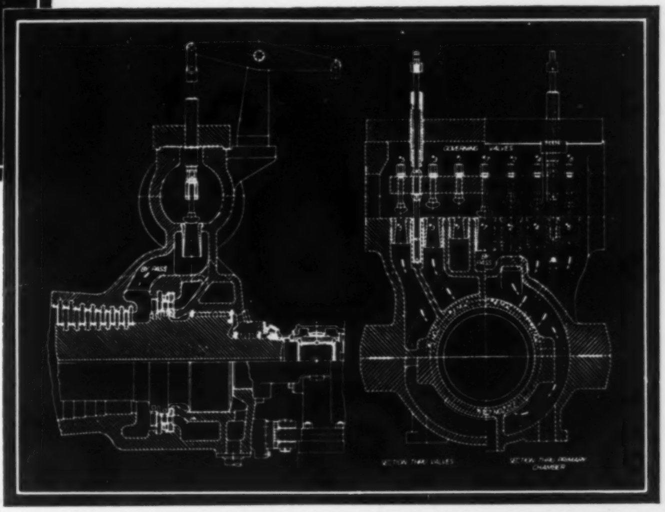
under each blade during assembly to hold it firmly against the shoulders of the groove while the shroud band is being fitted and welded.

Before leaving *Fig.* 3, it should be noted that the two groups of reaction blades have in one case radial seals only, and in the other both radial and axial seals. The axial seal strips in reaction blading were originally formed as an integral part of the shroud band. They are now made as separate free-machining stainless steel strips attached to the shroud by small rivets. Those on the rotating blade are under the shroud so the rivets do not carry any stress due to rotation. In this construction the sealing strips are quite easily replaced when after many years of operation this may be justified, without disturbing the blades themselves.

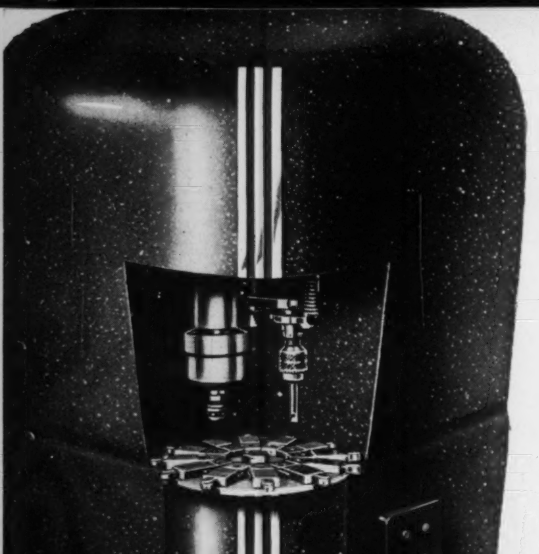
Radial seals, and the axial seals in dummy pistons, are made of thin rolled stainless steel strips in ribbon form held into retaining grooves by soft steel caulking rings. These are shown by *Fig.* 1. These ribbons are of .010, .015, or .020-inch thick stock or of tapered section, depending upon the conditions of service. The material is a free-machining variety of stainless steel that has been found capable of wearing away in contact without the generation of excessive heat and without serious galling or cutting of the mating surface. Of necessity it has very high physical properties even at high temperature, to enable it to withstand considerable pressure difference across each strip. Such sealing details are used in both stationary and rotating parts.

Having obtained a construction meeting requirements, it is desirable to start off a new turbine with the radial seal clearances small enough that they will probably rub away in early operation to the minimum possible clearance under any distortion that may occur in actual service. The axial seals are brought into contact while under load at normal operating speed by means of an external mechanism for shifting the rotor endwise, after which adjustment is made of the thrust cage liners to insure proper axial clearances for operating and for periods during which the turbine is shutdown.

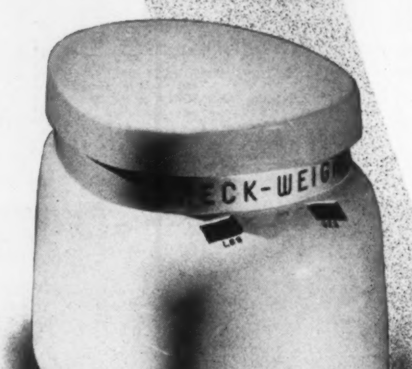
Mechanism for shifting the rotor in the axial direction embodies a Kingsbury thrust bearing cage which is moved endwise by rotation of a split yoke which has eccentric lugs which engage the thrust cage and fulcrum in the bearing pedestal. The proportions are such that one turn of the adjusting hand wheel moves the rotor .005-inch endwise. There are wedge-shaped stops on each side of the thrust housing. These can be adjusted from the outside with the turbine in operation, and set so that with the cage bearing against either its front or back limit stops, its position as regards axial seal clearances is known. For 3600-revolutions per minute turbines the movement of the rotor between running and start and stop positions is generally about .030 to .040 inch.



For successful operation at high steam temperature, it is essential that the cylinder structure be as symmetrical as practicable, and that it be uniformly heated. For this purpose, as shown by *Fig.* 4, the primary nozzle block is located in the cylinder base and steam is supplied to it from the first governor controlled inlet valve through an annular passage extending entirely around the high pressure end of the casing. The remaining steam inlet valves supply individual nozzle groups in the cylinder cover.



Large plastic moldings serve as platform and housing of attractively styled Sears-Roebuck scale, below. No springs or other working parts are visible and for reading registered weight, two small windows in housing show numbers in pounds and ounces. Scale can be produced in any of several colors



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Extreme building-in of parts is evident in the new Royce Drive-Matic drilling and tapping machine, above. New type chuck and jaws enable almost all shapes of metal work sizes up to ¾ inch to be inserted without additional fixtures. Machine will drill and tap 1200 pieces an hour

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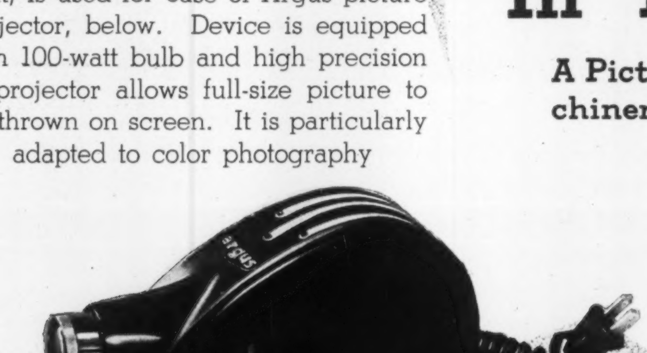
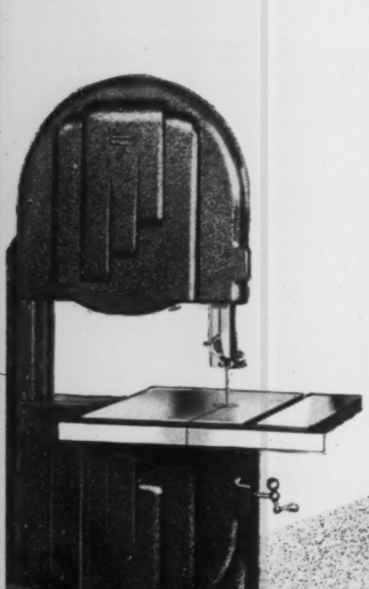
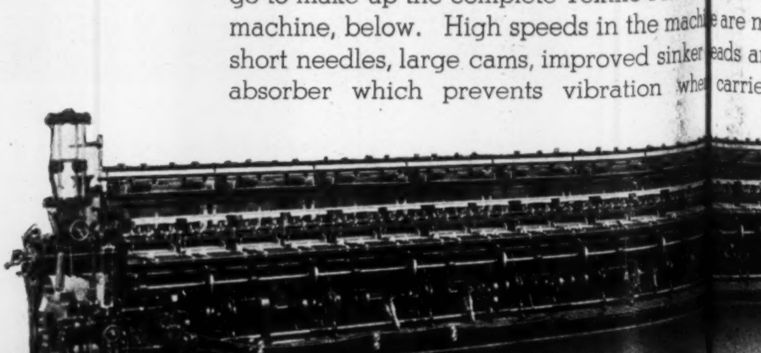
Molded plastic, which quickly dissipates heat, is used for case of Argus picture projector, below. Device is equipped with 100-watt bulb and high precision of projector allows full-size picture to be thrown on screen. It is particularly adapted to color photography





Supported by machined cast-iron trunnions, the heavily ribbed, nickel-alloy, cast-iron table of the Yates-American band saw, left, tilts 45 degrees right and five degrees left of the cutting line. For safety, blade is completely guarded and top saw guide carries a steel saw guard which covers the saw in every position

Twenty-four sections, each almost a comp te knit
go to make up the complete Textile Machin Works
machine, below. High speeds in the mach e are n
short needles, large cams, improved sinker eads a
absorber which prevents vibration whe carrie



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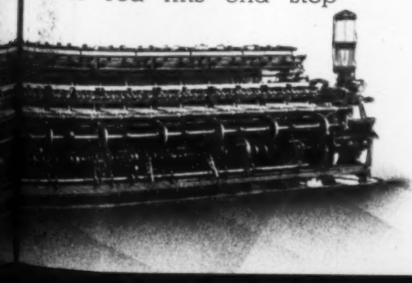
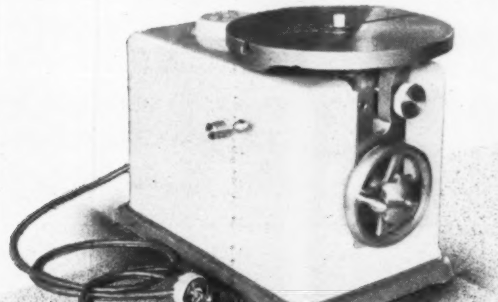
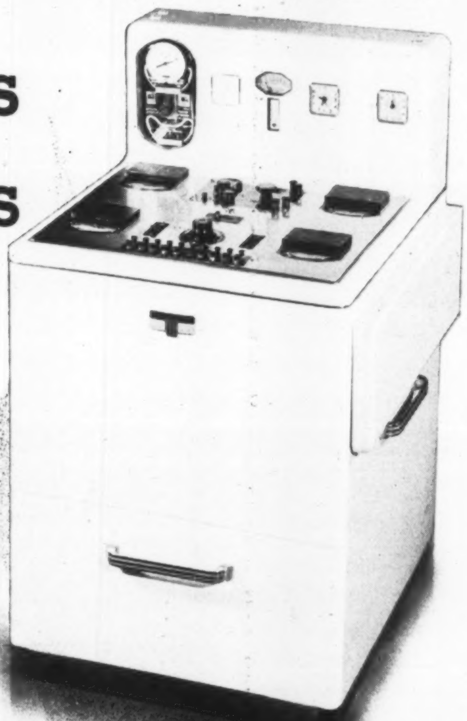
ker eads and a carrier rod shock
he carrier rod hits end stop

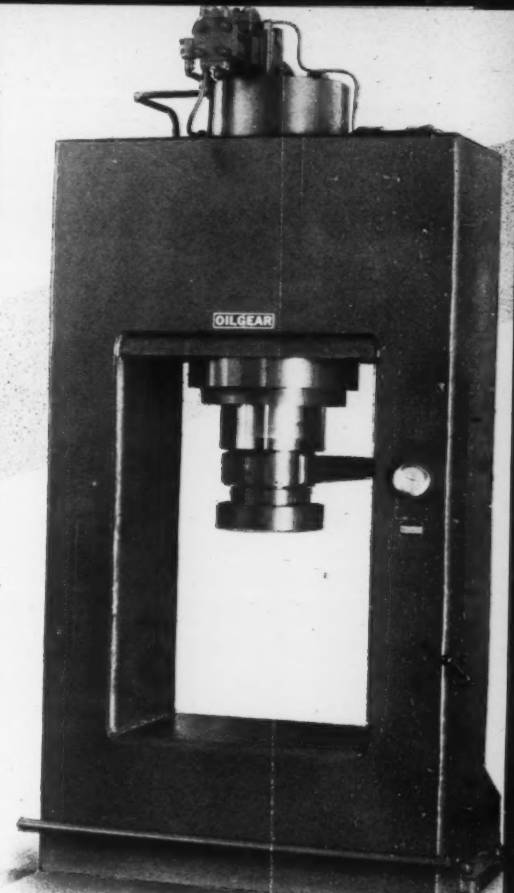


Ventilated cast aluminum housing encloses all moving parts of the Boyar-Schultz profile grinder, below. Belt driven spindle revolves at 20,000 RPM and also reciprocates in vertical direction to assure even wear of the wheel and give high quality ground surface



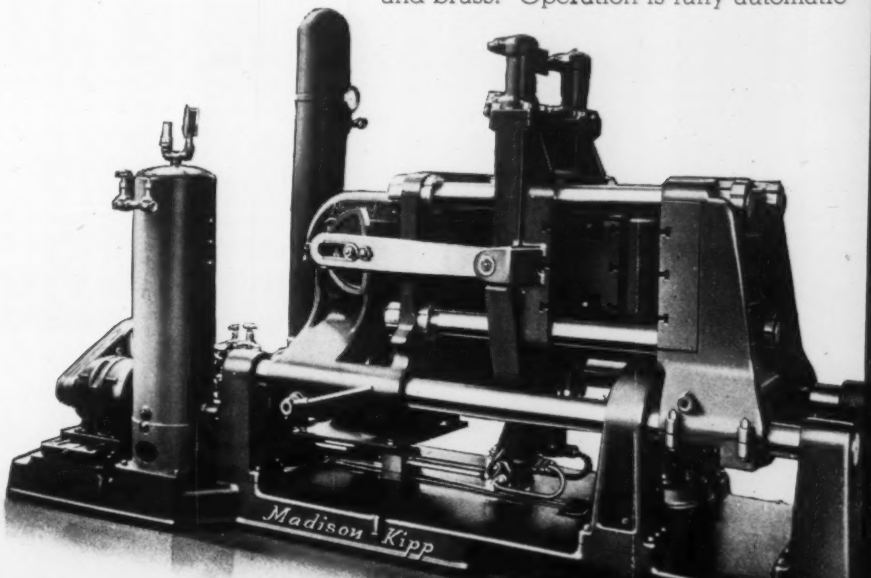
Consisting of a voltage regulator, wattmeter and voltmeter, watthour meter for measuring energy consumption and temperature recording instruments, a portable kitchen laboratory, below, for testing electrical devices has been developed by Westinghouse. Interior wiring is bare copper bus bars supported where necessary by refractory insulators





Main press structure of Oilgear 300-ton press, above, consisting of base, side frames, yoke and oil reservoir, is welded into one piece weighing 17,500 pounds. Hydraulic power drives piston at high speed on approach and return from work. The piston slows down automatically just before work is reached

Dies in the Madison-Kipp die casting machine, below, are locked together with four unique hydraulic wedge locks to hold over 750,000 pounds of casting pressure. Machine is especially designed for production of die castings from alloys of aluminum, magnesium and brass. Operation is fully automatic



Designers Can't Afford to Overlook Rapid Advance in Plastics

SIGNIFICANT events are taking place in the plastics industry and in the application of plastics to machines. Until a year or so ago designers were prone to consider plastic materials as being suitable only for novelties or for small parts of machines where electrical characteristics were important. This picture has changed. Plastic moldings have been produced recently so large that special molding presses had to be designed for their production, and developments in application have taken place so rapidly that it is rumored several automobile concerns are considering plastics as a possible material for auto doors, bodies and other parts. It is only necessary to step into a modern car and observe some of the numerous applications to which plastics already have been put by automobile builders, to realize that their further utilization is imminent.

Not only in the automobile industry has this type of material come to stay. Throughout the entire machinery field evidence of its steady encroachment upon applications formerly confined to metals and other nonmetallic materials is constantly coming to light. Examples immediately apparent are in radio construction, domestic appliances, vending machines and electrical machinery of all kinds.

The plastics industry deserves credit for the part it is playing in providing designers of machinery with new materials for consideration in design. Typical of the steps being taken to build the industry on a sound and workmanlike basis is the recent formation of a Society of the Plastics Industry which now holds, besides its business and social gatherings, technical sessions devoted to the fabrication and utilization of plastics.

Engineering societies and colleges also are recognizing the trend. The American Society of Mechanical Engineers, for instance, has instituted a Committee on Rubber and Plastics which is scheduled to hold extensive meetings and technical sessions, and some of the colleges already have inaugurated courses on plastics—just as was done in connection with welding some years ago.

Readers of MACHINE DESIGN cannot have failed to sense the importance this journal attaches to developments in plastics and their use in machines. An authoritative series of articles covering design and application of plastic parts has been published over the past year or so, the next part of which is to appear next month. Comprehensive plastic listings were included in the Directory of Materials published March, 1937, and as a fitting supplement to the articles and to the materials directory, a Directory of Custom Molders will be included in the forthcoming issue for August. Further, an outstanding book *Plastics in Engineering* is scheduled for publication as one of the MACHINE DESIGN series of books later this year.

Extensive coverage, but—to our minds—fully warranted!

Professional Viewpoints

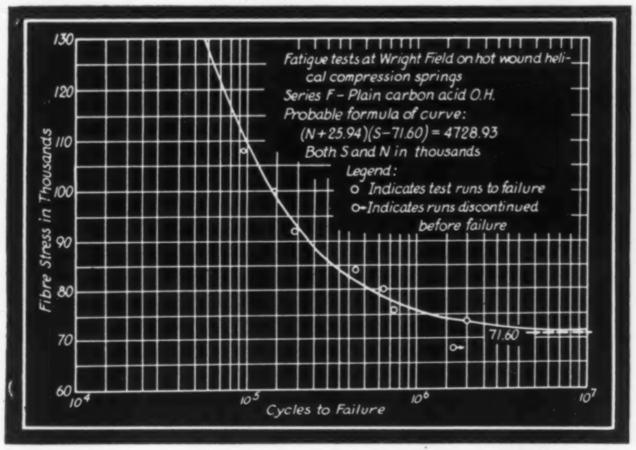
MACHINE DESIGN WELCOMES LETTERS SUITABLE FOR PUBLICATION

Additional Spring Data Offered

To the Editor:

IN THE third of A. M. Wahl's articles on "General Considerations in Designing Mechanical Springs," appearing in the March issue of MACHINE DESIGN, there are two points which merit further elaboration. I have had some correspondence with Mr. Wahl on the subject, and he suggests that this may be of interest to MACHINE DESIGN'S readers.

First: In the table showing "Endurance Test Results on Helical Compression Springs" there is a value of 58,200 pounds per square inch given for the endurance of electric carbon springs tested in a zero-maximum stress range, this value being ascribed to the present writer. This figure is one of those determined in the course of the current research on fatigue of hot-wound helical springs, conducted at Wright Field under the sponsorship of our committee.



The value mentioned was the result from the first group of springs tested in this research project, and the test procedure, still in the development stage, was sub-standard in several respects. Mr. Wahl, commenting on this situation, tells me that he included that figure in the tabulation to illustrate the "scatter" in test results, when springs and test conditions are below par.

Conversely, when the conditions are properly controlled, it would appear that very uniform results can be expected. To date the committee has results from three groups of springs that should be of permanent value. They are:

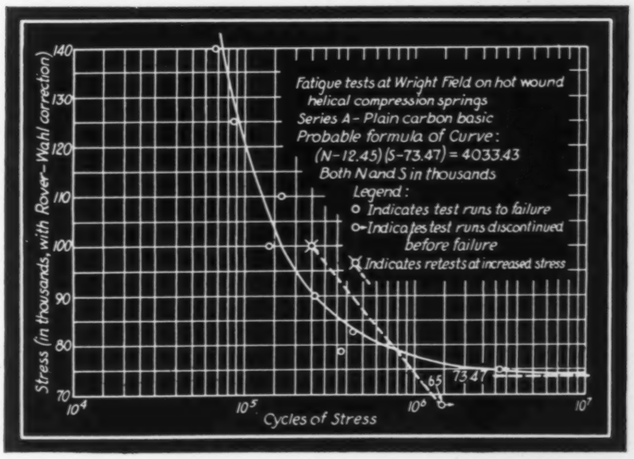
Plain carbon acid open hearth. .	71,600 psi
Plain carbon basic open hearth. .	73,470 psi
Plain carbon electric	75,600 psi

The third of these groups constituted a repeat lot in place of the substandard group above mentioned. Springs in all three groups were of ¾-inch round bar, index 5, and were fabricated from "as rolled" steel.

These endurance figures, together with most of the other values tabulated by Mr. Wahl, show a gratifying uniformity, and I should say they strongly support the tentative conclusion that the endurance limit of plain carbon springs of excellent manufacture, in the size range covered, tested in a zero-maximum stress range, is 70,000 to 75,000 psi.

Accompanying prints of the S-N curves for the three groups referred to show the test procedure was planned so as to develop complete S-N curves, rather than merely the endurance limits. The probable values of the latter are calculated from the test data by a variation of the method of least squares. This leads up to the second point which requires further comment.

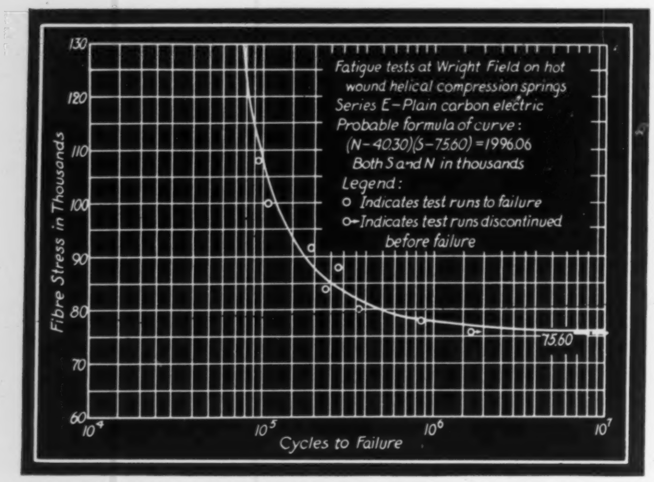
Under the caption "Springs Subjected to Few Stress Cycles" it is stated that there is very little data at hand. This phase of spring design is of great interest to the industry. Many spring users are not accustomed to getting, or paying for, springs that will last forever; usually the failure of a spring in service is not a "catastrophe," and space limitations are often a controlling condition. Therefore the spring user is apt to think in terms of longest life per dollar



of cost, rather than indefinitely long life regardless of cost. These were among the considerations that decided the committee to work out complete S-N curves in their tests.

In the data tabulated by Mr. Wahl on this point there is a figure mentioned for springs of acid steel—10,000 cycles of life at 130,000 psi stress. This value was reported by J. B. Johnson, Chief of Material Branch at Wright Field, from one of a series of tests he made, ante-dating the current committee project. These acid springs made the poorest showing of any lot tested by Mr. Johnson, and examination of the reported data fully accounts for this; the heat treatment was freakish, structure of the steel was found to be largely martensitic, and the surface was seamy.

Here, again, Mr. Wahl tells me that his object in including this particular figure was to illustrate the variation in test results when test conditions are not under good control. And again we find that with good control a satisfactory degree of uniformity is attainable. Other results reported by Mr. Johnson, on chrome-vanadium, silico-manganese, and plain carbon electric springs, all show an endurance of 100,000 cycles at 110,000 to 130,000 psi maximum stress. These figures are in good agreement with the committee's results, as indicated on the attached charts. A figure of 110,000 psi is about as high a stress as we could use in general design of carbon steel springs, and still provide for a reasonable reserve movement about solid height. So another tentative conclusion may, I think, be justified: Any plain carbon hot-wound spring, of good design, material, and workmanship, should be expected to have an endurance of not less than 50,000 to 100,000 cycles of its maximum working stress.



Please understand that these remarks are in no sense intended as criticisms of Mr. Wahl's work. In fact, this series of articles is a noteworthy contribution to the literature on the subject. Much of our current helical spring theory has been developed quite recently, and so far as I know none of the standard textbooks and manuals present any adequate treatment of it. Mr. Wahl's work is, therefore, very timely, and his lucid and scholarly exposition of the new ideas about springs maintains the high standard set by his research work of a few years ago.

Please put me down for one of the reprints of the series. We should have this in our committee files.

—C. T. Edgerton, *Secretary*
A.S.M.E. Special Research Committee
on Mechanical Springs

Now Is Time for Patent Action

To the Editor:

I HAVE had the pleasure of reading your editorial on the bill covering compulsory licensing of patents and can concur with you in the criticism you have made against the bill.

I especially endorse the statement in the last paragraph that it behooves engineers and their societies, manufacturers and other parties likely to be affected by this legislation to take such steps as may be necessary to make the bill a worthwhile measure. The time to take such action is now and for the next few months while Congress is adjourned.

When one considers the deliberation and comprehensive study given to some academic question, such as the fraction of a split thousandth of an inch to be used on some manufactured part as, for instance, in engineering standards work, it certainly seems worthwhile to study such a problem as the patent law.

I am definitely convinced that the proposed bill has considerable basic merit, especially if it will permit the exploitation of patents taken out by individuals who lack business enterprise or funds to exploit them, or who have an exaggerated notion of the value of their patents and thus prevent their public use; also to prevent patents being shelved for monopolistic purposes, and to induce co-ordinated development of patents taken out for the same idea.

—Joseph S. Pecker
Philadelphia

Air Conditioner

(*Concluded from Page* 29)

motor. A coating of sound insulating material, glued inside of the casing, deadens noise from air movement or rotating parts. To eliminate vibration transfer from compressor to frame, suction and discharge lines are made extra long and contain a number of bends.

Thus, by ingenious design a mechanism is now available occupying little more space than a small desk which completely conditions air in several rooms. Noise, the primary evil of any mechanical unit, has been overcome successfully and one has every reason to believe that such machines will be as common as the radio or electric refrigerator in a few years.

Men of Machines

GEORGE D. SHAEFFER, who has had considerable experience and is well known in the field of design and manufacture of road building machinery, has recently been appointed chief engineer of the road machinery division of Gar Wood Industries Inc., Detroit.

A native of Ohio, Mr. Shaeffer graduated from Ohio Northern university in 1921, receiving a degree of bachelor of science in mechanical engineering. His first position upon graduation was with the Fate-Root-Heath Co., Plymouth, O., where he was employed designing gasoline locomotives. Later for several years, he was associated with the road building machinery division of Allis-Chalmers Mfg. Co. Previous to his present appointment, Mr. Shaeffer served for eleven years as chief engineer of the road machinery division of W. A. Riddel Corp., Bucyrus, O

GEORGE D. SHAEFFER

• • •

FLOYD F. KISHLINE

PROMINENT in the motor car industry, Floyd F. Kishline has become chief engineer of Willys-Overland Motors Inc. As chief engineer for twelve years of Graham-Paige Motor Corp., he did outstanding work in developing the modern type supercharger and also in connection with increasing power output of the engine in relation to its fuel consumption.

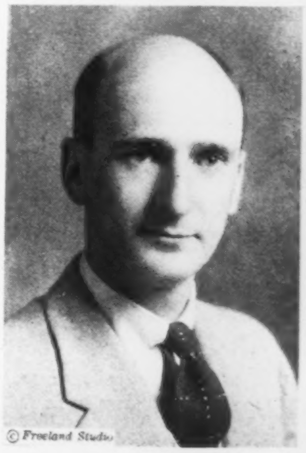
Prior to this connection he was engineer for Universal Products Co., working on automotive drive systems. For two years preceding, he was in charge of engineering for the Graham Truck division, Evansville, Ind. He became associated with Graham Truck after serving in the Motor Transport division of the United States Army. Mr. Kishline may be called "The pioneer in American automotive engineering of supercharging construction."

• • •

WIDELY known for his research in elasticity, plasticity and advanced dynamics, Dr. J. N. Goodier has been named acting professor of mechanics in the Sibley School of Mechanical Engineering of Cornell university. He was formerly connected with the Ontario Research Foundation where he has been research fellow in applied mechanics since 1931.

Born in Preston, England, Dr. Goodier won a scholarship to Cambridge university where in 1927 he received his B. A. degree, passing first class examinations in mathematics and the mechanical sciences. He also won the Rex Moir prize for general distinction in the mechanical sciences, the Ricardo prize for thermodynamics, and the Winbolt thesis prize.

At the University of Michigan, from 1929 to 1931, he was a Commonwealth Fund fellow, assisting Prof. S. Timoshenko in the preparation of



J. N. GOODIER

his book, "The Theory of Elasticity," and doing research. In 1931 he received doctorates from Cambridge and Michigan. He is credited with two patents on industrial viscometers and is the author of numerous technical articles.

* * *

C. H. CARPENTER, who has been associated with the Lee Wilson Engineering Co., Cleveland, about two and a half years, has been made chief engineer.

◆ ◆ ◆

ROBERT H. HEYER has received the Charles B. Dudley medal of the American Society for Testing Materials for his paper "Analysis of the Brinell Hardness Test" which is "an outstanding contribution in the field of research." Mr. Heyer is metallurgist in the research laboratories of American Rolling Mill Co.

◆ ◆ ◆

CONSTANT BOUILLON recently completed fifty years of employment with the Hendy Machine Co., Torrington, Conn., of which he is chief engineer.

◆ ◆ ◆

W. R. FILLER, prior to accepting his present appointment as sales engineer of the Timken Detroit Axle Co. was chief engineer of the White Motor Co., Cleveland.

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RUFUS E. ZIMMERMAN, vice president of research and technology of United States Steel Corp., has been awarded the doctor of science degree by Franklin and Marshall college, Lancaster, Pa., of which he is a graduate.

◆ ◆ ◆

H. B. RICE has joined the engineering department of the Metallizing Co. of America Inc., Los Angeles. Formerly vice president of the Metalspray Co. Inc., Mr. Rice will continue his work in the process development fields.

◆ ◆ ◆

KENNETH H. DONALDSON, temporary head of the department of metallurgical engineering at Case School of Applied Science, Cleveland, has been made permanent head of that department.

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DR. W. R. WHITNEY has been awarded the Marcellus Hartley gold medal by the National Academy of Sciences for his creation and development of the General Electric Research Laboratory, of which he is vice president.

◆ ◆ ◆

WILLIAM P. WOODSIDE has been nominated for president of the American Society for Metals, succeeding Dr. George B. Waterhouse. Mr. Woodside, who is vice president of Climax Molybdenum Co., Detroit, is the present vice president and has previously served as trustee and treasurer of the society.

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WESLEY P. SYKES, metallurgical engineer, General Electric Co., Cleveland, has been awarded the honorary degree of doctor of engineering at the Case School of Applied Science, Cleveland.

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ARTHUR L. COOK has been named acting director of the Pratt Institute's school of science and technology, succeeding Dr. Samuel S. Edmands, deceased. Mr. Cook has been head of the institute's department of engineering for 25 years. CLIFFORD C. CARR, an instructor in electrical technology, will succeed Mr. Cook.

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DR. VANNEVAR BUSH, vice president and dean of engineering of the Massachusetts Institute of Technology, has been appointed president of the Carnegie Institution of Washington. He succeeds DR. JOHN C. MERRIAM, retired.

◆ ◆ ◆

HALVOR O. HELM, chief engineer of Toledo Scale Co., has been elected president of the National Scale Men's association. Mr. Helm has also recently been awarded life membership in the American Society of Civil Engineers.

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F. ELLIS JOHNSON has been appointed dean of the engineering college of the University of Wisconsin, filling the vacancy caused by the retirement of Dean F. B. Turneaure. Dean Johnson, who is an alumnus of the Wisconsin university, was previously dean of the college of engineering, University of Missouri.

◆ ◆ ◆

DR. ALAN MORRIS has been promoted from research engineer to chief metallurgist of Bridgeport Brass Co., Bridgeport, Conn., in which position he will be in charge of the physical and chemical laboratories as well as research activities.

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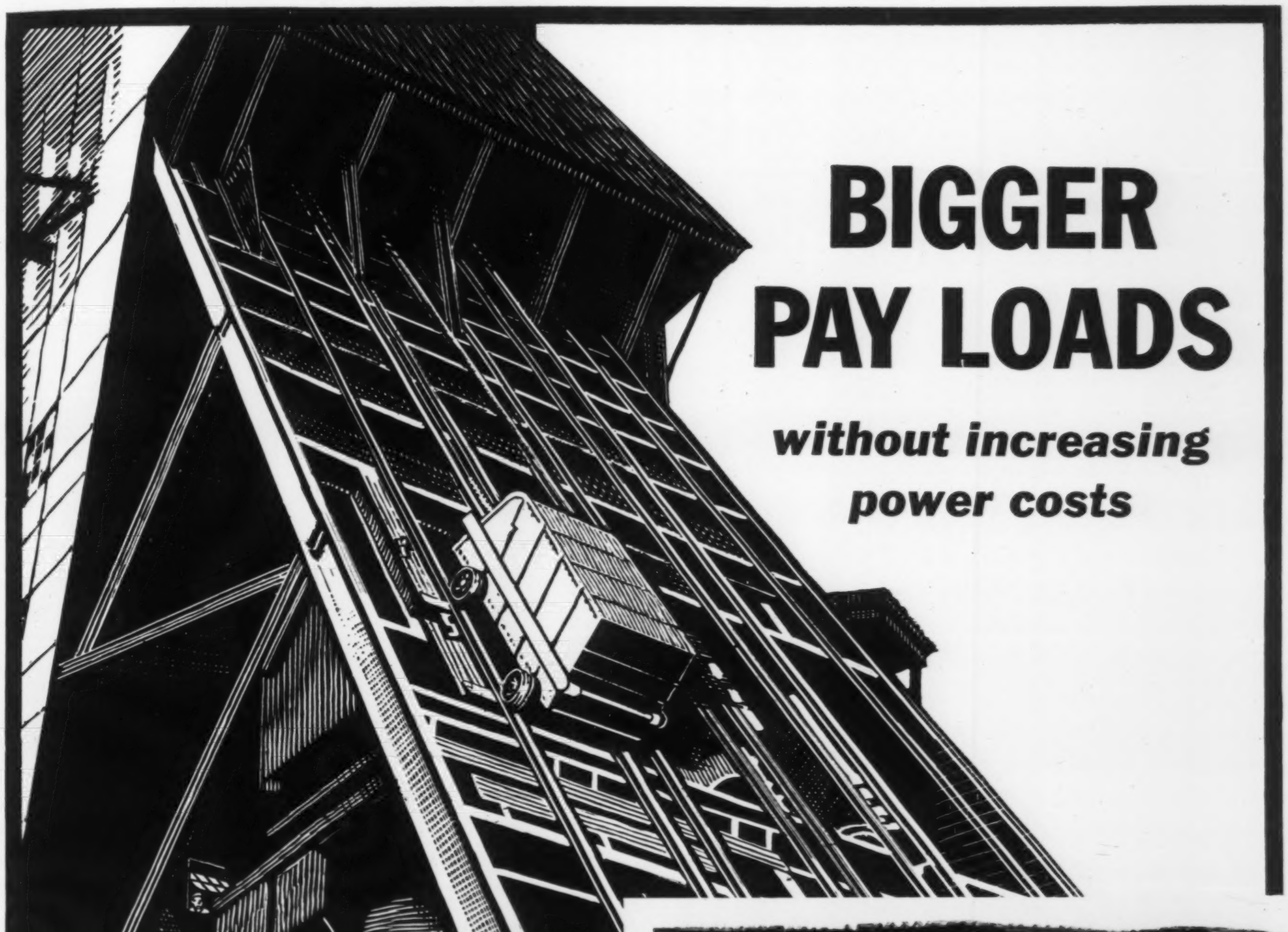
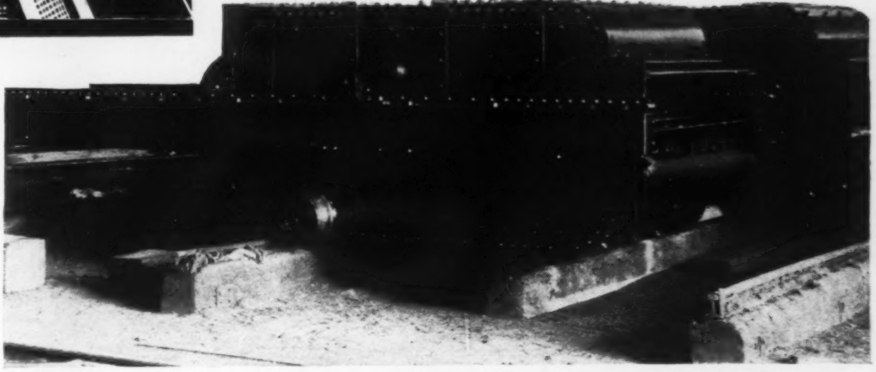
K. L. HANSEN has received the first honorary professional degree of electrical engineer to be granted by the college of electrical engineering of the Milwaukee School of Engineering. Mr. Hansen, who is a director of the welding institute established by the school several years ago, is a well-known inventor in the welding field and consulting engineer of Harnischfeger Corp., Milwaukee.

BIGGER PAY LOADS

without increasing power costs





● This sturdy Nickel Alloy Steel ore carrier, weighing 12,000 lbs. unloaded, has replaced a carbon steel skip weighing 15,000 lbs. The saving of 3000 lbs. in dead-weight has been translated into greater pay load capacity, raising the hoisting capacity from 19,000 lbs. to 22,000 lbs. without increasing power costs. The high strength-weight ratio of the Nickel Alloy Steels, combined with their unusual toughness, make it possible to increase the capacity of haulage equipment of many types without increasing weight.

NICKEL ALLOY STEELS

● The side frames and bolster castings of this hopper car truck were made of Nickel Steel, effecting a saving of 20% in the weight of trucks without decrease in the required properties of strength and toughness. Our engineers will be glad to consult with you and to suggest how the Nickel Alloy Steels will save you money.

THE INTERNATIONAL NICKEL COMPANY, INC., 67 WALL ST., NEW YORK, N. Y.

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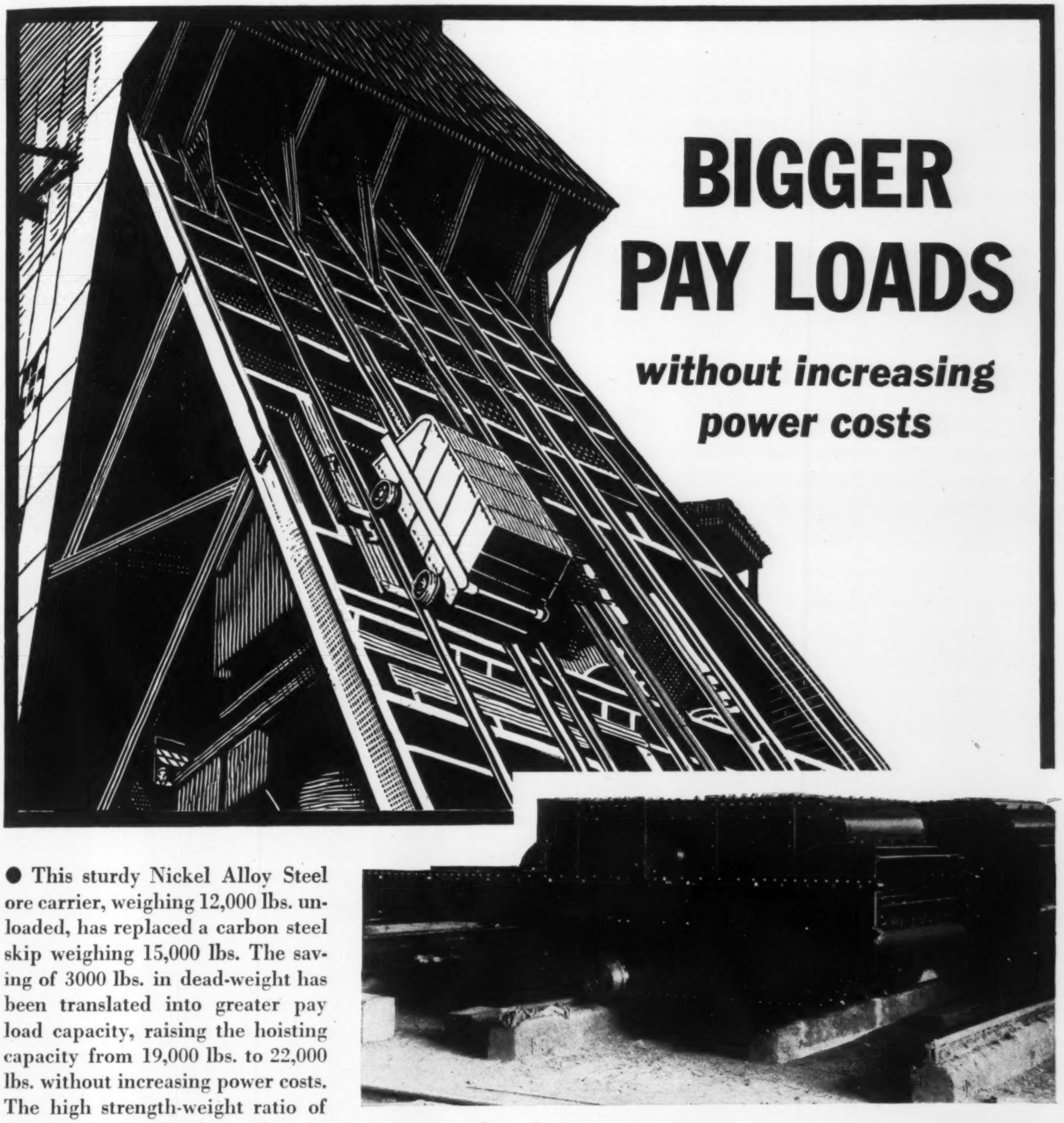

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THE INTERNATIONAL NICKEL COMPANY, INC., 67 WALL ST., NEW YORK, N. Y.

Noteworthy Patents

CONSTRUCTION depicted by *Fig.* 1 is designed to enable a locomotive to remain safely operative under its own power even though its crosshead shoes or guide liners become excessively worn or are lost entirely.

This invention is illustrated in connection with a standard multiple guide which is located above and parallel to the piston rod and supported at its forward end by the cylinder head and at the rear by a bracket secured to the locomotive frame. Design of the multiple guide is shown clearly by the supplementary views below the side elevation—by the enlarged cross section in particular.

Bearing surfaces in this multiple guide are lined with flat plates of brass or other suitable bearing metal and those surfaces of the crosshead which are fitted to slide within it are faced with shoes of metal selected to run well on the guide liners.

The "emergency guide" which is the feature of this invention is a flat rail parallel to the multiple guide but located below the connecting rod. As indicated by the enlarged section there normally is clearance between the upper surface of this lower guide rail and the bottom face of the crosshead, this clearance being less than the thickness either of upper guide liners or shoes. However, if these liners or shoes become excessively worn or fall out, then the lower rail comes into action as a guide, enabling the locomotive safely to complete its run.

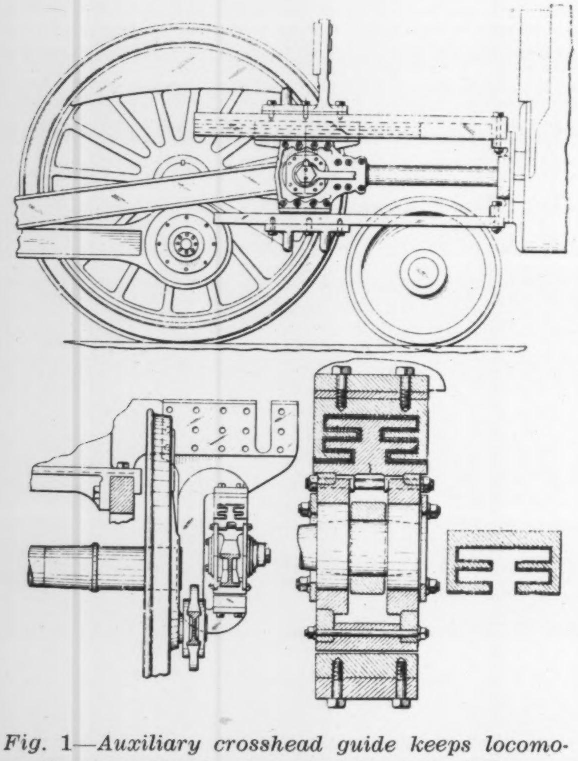


Fig. 1—Auxiliary crosshead guide keeps locomotive operative in case of main guide failure

Patent No. 2,110,104 granted to Tracy V. Buckwalter of Canton, O., and assigned to the Timken Roller Bearing Co., covers this development.

Cuts Locking Tongues on Work

CARL G. OLSON of Chicago has assigned to the Illinois Tool Works his patent No. 2,112,494 covering a system of self-locking screws, bolts and nuts.

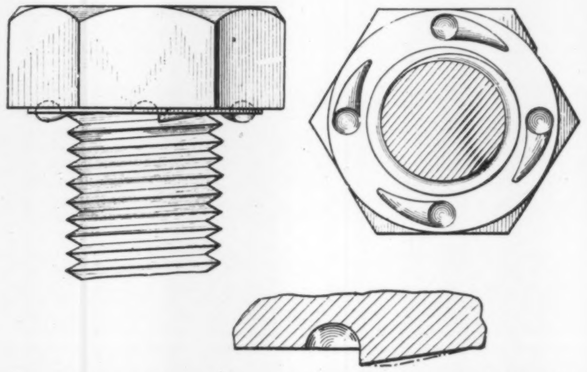


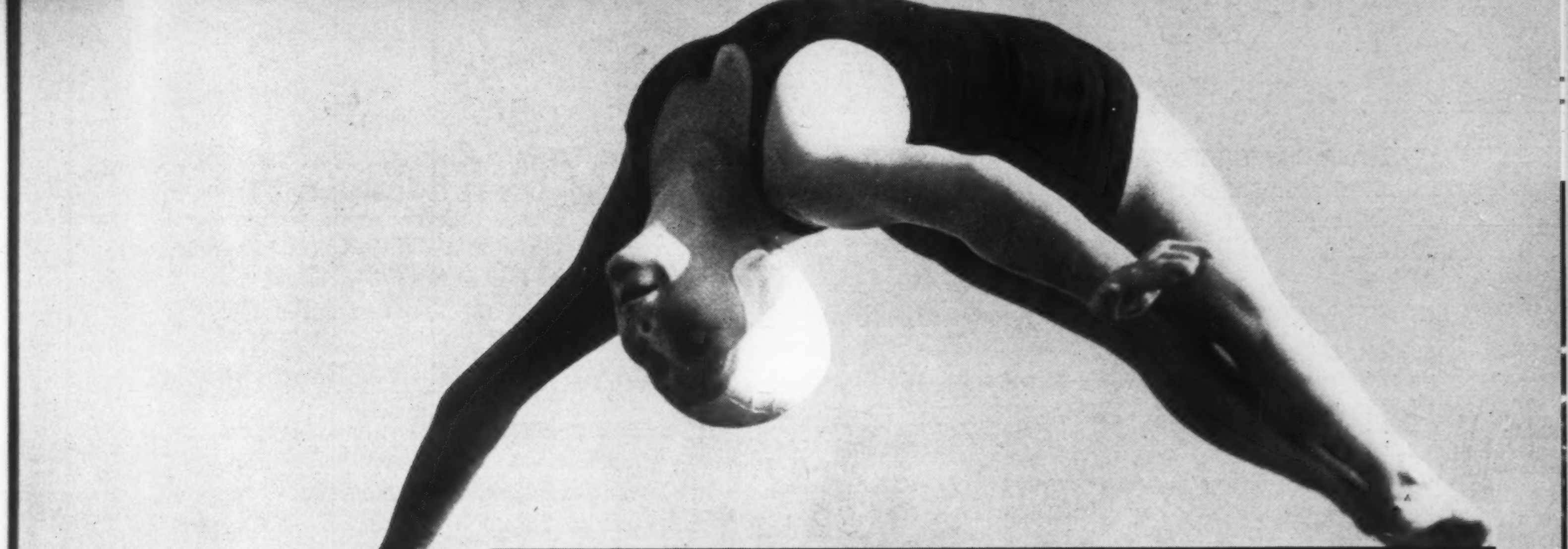
Fig. 2—Cutting tools upset on bolt or nut raise tongues on work which lock the fastening

Details of this system as adapted to hexagon head cap screws, are shown in *Fig.* 2.

The object of the invention, as set forth by Mr. Olson in his patent is ". . . to provide locking devices such as self-locking screws and self-locking nuts having means in association with the clamping surfaces thereof for cutting and subsequently crowding into the confines of the clamping side of such devices material of the work so as positively to secure against inadvertent loosening."

More specifically, the invention contemplates locking devices wherein the clamping side is provided with relatively shallow indentations or pockets in operative association with cutting edges adapted to cut and subsequently to crowd material into the recesses during final tightening of the screw or nut.

The illustration clearly depicts the manner in which the pockets are formed in the face of the fastening, thereby upsetting some of its material into the form of small cutting tools. The screw or nut is of



Marjorie Gestring, graceful Los Angeles diver, makes the difficult "back dive" look easy at a Women's National A.A.U. meet.
(Acme Photo)

Dumore type W Motor.

Like a Champion of a Diving Event

A DUMORE MOTOR HAS THAT EXTRA "SOMETHING"

"Now, I'm convinced that I can't afford to risk the reputation of our company by accepting power units short of the standards you fellows have set up," was the comment of a buyer for a large eastern manufacturer as he completed a tour through the Dumore plant. "I have seen that there's more to a motor than what appears on the surface . . . I know you're not fooling when you contend that you actually build 'extra power hours' into Dumore Motors," he added.

What this gentleman saw was a method of manufacture that has been Dumore's policy for 25 years: (1) Armatures dynamically balanced to *eliminate vibration,* (2) commutator leads swaged by special Dumore process to assure *100% electrical contact,* (3) commutators ground concentric with bearings for *longer brush life,* (4) armature windings expanded, then sealed, to *prevent centrifugal "breathing",* (5) motors inspected *5 times* in manufacture and run-in to *seat brushes properly.*

Do as other exacting manufacturers do . . . select a Dumore universal (AC-DC) motor for your power problem. They are available in 1/500th to 2/3 h. p. . . . 0 to 60 cycles. The counsel of Dumore engineers is available without obligation. Write today for facts and engineering service application blank.

SPECIFICATIONS TYPE W MOTOR

Type, Series (Universal); volts, 115, 0-60 cycles; horsepower, 1/8 A. C. — 1/2 D. C.; speed, 6500 r.p.m. full load; watts input, 460 A. C. — 604 D. C.; duty, continuous; temperature rise, 40 C.; method of cooling, internal fan; bearings, grease sealed ball; housing material, cast aluminum; finish, black crinkle enamel; weight, 7 lbs. 7 oz.

THE DUMORE COMPANY . DEPT. 128-G . RACINE, WIS.

DUMORE MOTORS

FOR Extra Power Hours

course hardened following this upsetting. In action these protuberances actually do perform as true metal cutting tools, their "feed" being furnished by the lead of the screw.

The "tools" shown in *Fig.* 2 are designed so that when the screw head is tightened down against a firm work surface, their cutting action will have taken place during not more than one-quarter turn. In that quarter turn substantial tongues or chips will have been crowded up into the locking recesses.

Offset Determines Volume

CHARACTERIZED as a compressor-motor apparatus, the mechanism which is shown in section by *Fig.* 3 is covered by patent No. 2,096,074 issued to John E. Stevens of New York.

Mr. Stevens explains that by "compressor-motor apparatus" he means that the device is such that when driven by mechanical means it will operate as a fluid compressor, while on the other hand if fluid be introduced into it under pressure it acts as a motor.

The action depends upon differential travel of four sector pistons. These are revolved within a cylinder block by lugs on the drive shaft and are sealed on their inner faces by a slotted sleeve which revolves with the drive shaft. The cylinder block is provided with means for sidewise adjustment within its casing. By this means its bore can be set to various degrees of eccentricity in relation to the fixed-center drive shaft. In this manner the differential travel of the sector pistons can be varied thus affording exact volumetric control from zero to maximum without requiring change in speed of the drive shaft.

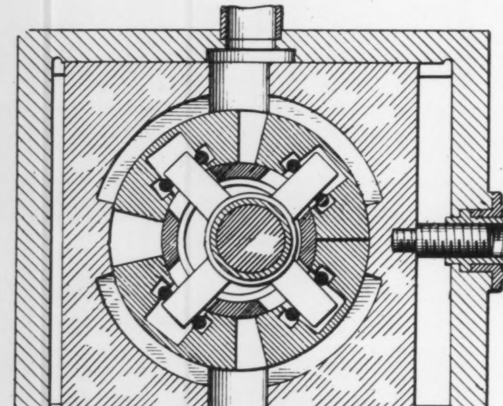


Fig. 3—Sidewise adjustment of cylinder block gives volume control of segmental piston pump

If the pump shown in the diagram be considered as turning in a clockwise direction, the lower port will be the intake and the upper the outlet. Starting at the right in direct contact, the sector pistons gradually draw apart through their first 180 degrees of travel and gradually close together again during the last 180 degrees. Thus the liquid which is drawn between them from the lower reservoir is carried over to, and squeezed out into, the upper or outlet reservoir.

Combines Coil and Ring Springs

ENHANCEMENT of the durability and efficiency of springs and improvement of their lubrication, are among advantages claimed for a composite system recently patented in the United States by Karl Scharfenberg of Berlin-Nicolassee, Germany. His patent is No. 2,101,721.

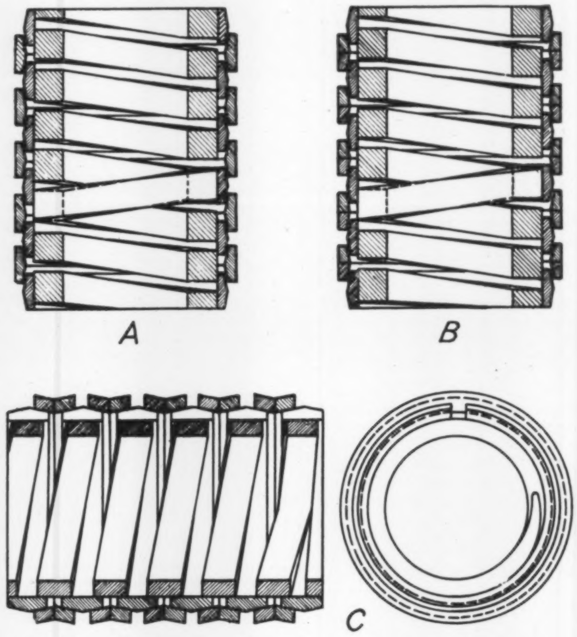


Fig. 4—Combination spring consists of a coil surrounded by a stack of nested spring rings

Shown in *Fig.* 4 are three variations, all of which involve a coiled spring surrounded by a stack of nested beveled spring rings. The basic idea is depicted by view *A*, while views *B*, and *C* show variations involving two types of dual outer spring rings.

When the composite spring is compressed, the coils of the main or inner member come closer together and their diameter increases. At the same time three is a tendency for the diameter of the inner spring rings to decrease as their beveled peripheries are forced into the inside bevels of the outer rings, this being true especially when the inner rings are cut apart as shown in the end view *C*. The effect is that the ring springs and the coil spring offer mutual support. Positive expansion insures effective ring lubrication.

The idea of the divided outer rings illustrated in views *B* and *C* is to allow free rotation between groups of rings to correspond with turning effect which takes place in coils of the inside spring during compression.

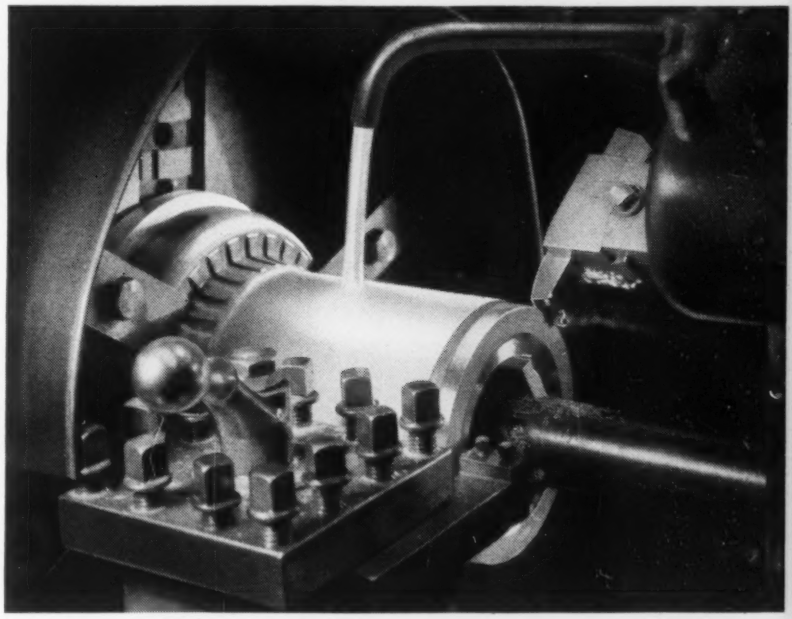
Dowmetal

lightest of structural alloys is one of the

EASIEST TO MACHINE

This workman has been able to machine the highly finished parts in background ......

......17 per cent faster from DOWMETAL castings like this than from any other metal of equal strength.



DOWMETAL*, in addition to endowing products everywhere with new lightness, is effecting important savings in their production costs.

The experience of The National Acme Company, Cleveland, Ohio, includes machining operations on every kind of metal. They find that DOWMETAL is one of the easiest of all to machine. It has no tendency to drag, tear or chip out. Heavy cuts and feeds may be taken at high speeds without excessive heating of cutting tools or work. Their cost records show that castings made of DOWMETAL can be machined for 17 per cent less than those made of any other structural alloy.

These unique properties of extreme lightness and exceptional machinability, combined with strength, toughness and durability, have led manufacturers to incorporate DOWMETAL in nearly every type of product.

Perhaps your product is handicapped by needless weight. Let us show you how DOWMETAL has brought outstanding advantages to the products of countless industries. Write today for copy of the booklet, "Industry's Lightest Structural Metal" showing many of these DOWMETAL applications.

THE DOW CHEMICAL COMPANY
Midland · *Dowmetal Division* · Michigan
Branch Sales Offices: 30 Rockefeller Plaza, New York City; Second and Madison Streets, St. Louis; Field Building, Chicago; 1400-16th Street, San Francisco; 2260 East 15th Street, Los Angeles

DOWMETAL
MAGNESIUM ALLOYS
LIGHTEST OF ALL STRUCTURAL METALS

DOWMETAL *is available in sand, permanent mold and die castings, sheet, strip, plate, forgings, standard and special extruded shapes. It is one of the easiest of all metals to machine.*

*Reg. U. S. Pat. Off

Let's get

TO THE *Point!*

What makes "Castell" the world's finest drawing pencil? Let's get right to the *point*—preferably on your own drawing board. Note how smoothly it glides, how uniformly it covers. No gritty spots to grate on your nerves. No scratching. No flaking or smudging. Use it blunt. Now on the flat side for broad strokes. Now sharpen it to a needlepoint for delicate hair-lines. Bear down hard—"Castell" takes a whale of a lot of pressure without snapping off.

Frankly, Mr. Architect, Engineer and Draftsman—isn't this the best all-around, most satisfying pencil you ever used?

No Grit
No Scratch
No Smudge

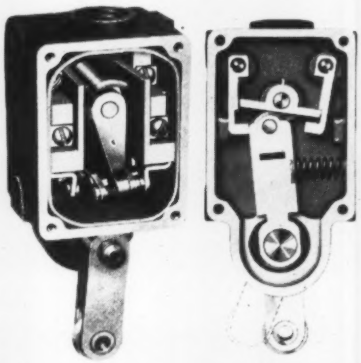
"CASTELL"
DRAWING PENCIL ★ 15c
In the metal box
MADE IN BAVARIA

A·W·FABER·Inc. NEWARK, N. J.

NEW Materials and Parts

Switch Has Many Applications

SNAP-LOCK" switches, adaptable for machine limit switches, conveyor lines, safety switches, counting switches or handling single-phase motors up to one horsepower at voltages as high as 440, have just been developed by The National Acme Co., Cleveland. Machined parts are used throughout the switch, giving it a long lasting, precise mechanism. Under test these switches have operated 1,000,000 times without sign of appreciable wear. Features of the new switch line include snap-on and snap-off contact, contacts locked in positions, electrical contacts in separate enclosure from operating mechanism, two double-break circuits, either of which can be normally open while the other is closed. Light pressure and 10 degrees of travel operates the switch with an additional over-travel of 29 degrees. Switch is compact, oilproof and dustproof.



Machined parts are used throughout switch giving long life and precise making and breaking of circuits

New Variable Speed Models Announced

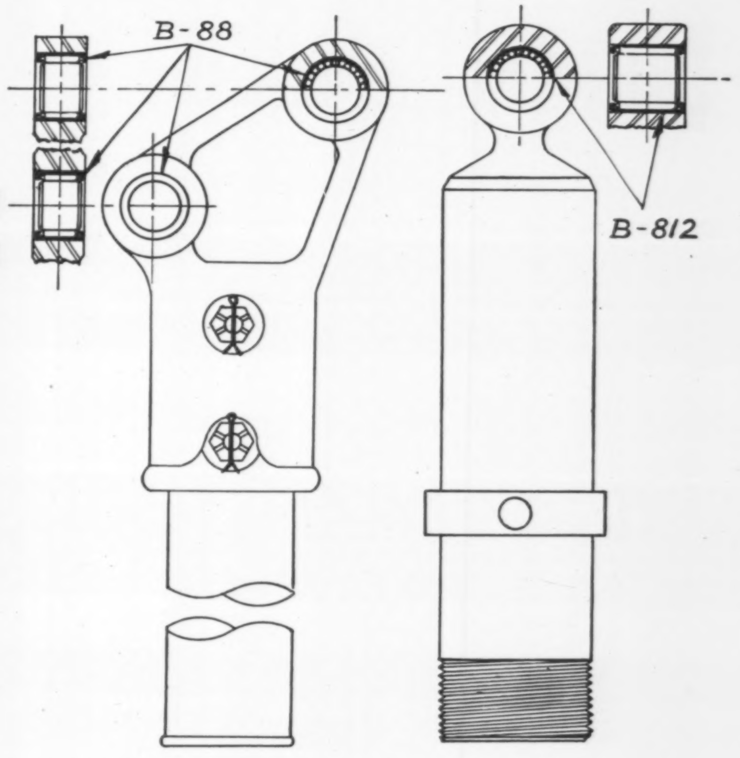
NEW models of the Graham variable speed transmission with important additional improvements which broaden the scope and application of this type of equipment, have been announced by Graham Transmissions Inc., 2711 North 13th street, Milwaukee. By means of an ingenious device, which automatically keeps the driven pressure in proportion to both the load and the speed, the transmission maintains full torque all the way to zero speeds. It transmits full motor power over a range of 4 to 1, and gives speeds in infinite steps from any desired maximum to zero and reverse. Speed is adjustable, either stationary or running. For rayon machines and similar applications requiring automatic control with extremely close speed regulation, this trans-

TORRINGTON NEEDLE BEARING

DESIGN AND SERVICE FEATURES

COMPACT BEARING DESIGN SAVES WEIGHT AND SPACE

Is Ideal Anti-Friction Unit for Aircraft Construction



NUMBERS ARE TORRINGTON NEEDLE BEARING CATALOG NUMBERS FOR STANDARD TYPES AND SIZES.

THE COMPACT DESIGN of the new Torrington Needle Bearing aids materially in reducing weight and size—a vitally important factor in aircraft equipment, which must be stripped of every superfluous ounce. The hydraulic hand pump shaft and handle assemblies illustrated are typical aircraft control applications. Others, where its use is suggested, include: engine control units, control pedestal heads, hydraulic hand pumps, bomb rack releases, hydraulic valve levers, hydraulic valve cams, landing light controls, cracking valves and hydraulic hand pump piston rods.

Not only is the Needle Bearing itself light in weight, but its construction permits a marked decrease in housing weight also. Because the bearing is small radially and long axially, it requires only the simplest type of housing structure.

High Radial Load Capacity

The bearing's full complement of small-diameter needles gives many inches of linear contact, and results in high radial load capacity. Low coefficient of friction provides all the advantages of full anti-friction construction—and the bearing requires no more space than a simple bushing.

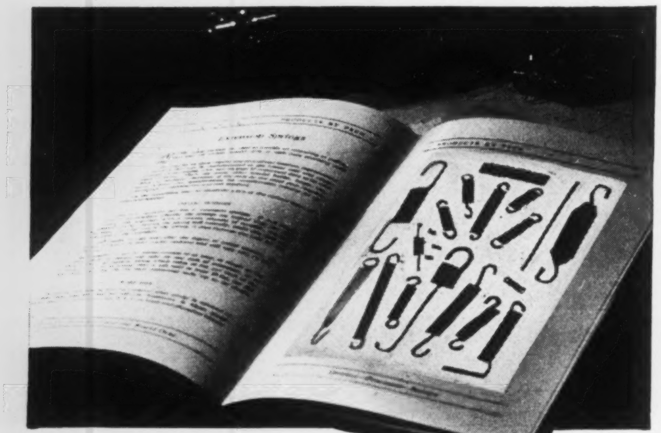
Lubrication of the Needle Bearing is extremely simple. The turned-in lips of the hardened retaining shell hold an ample supply of lubricant for long periods of operation.

For locations exposed to the elements the hardened retaining shell can be furnished with cadmium plating.

The Torrington Engineering Department will assist in the selection of bearings for specific load requirements, and will cooperate when desired in the laying out of applications. Further information is given in the Torrington Needle Bearing Catalog, available on request. Write for Catalog No. 9.

The Torrington Company
ESTABLISHED 1866
Torrington, Conn., U.S.A.
Makers of Ball and Needle Bearings
Branch Offices in all Principal Cities

TORRINGTON
NEEDLE BEARING



Belongs on every busy man's desk—this free DATA BOOK AND CATALOG

This useful book shows, by photos and accurate diagrams, the different kinds of springs (extension, compression, torsion, etc.) and gives full data on their characteristics and adaptability to various types of service; also wire tables, gauge tables and decimal equivalents. There is, of course, a valuable screw machine parts section. If you have to do with product design or purchasing, this book should be on your desk. A request on your company letter head will bring you a copy.

PECK SPRINGS
AND SCREW MACHINE PARTS
The Peck Spring Co. 10 Wells St., Plainville, Conn.

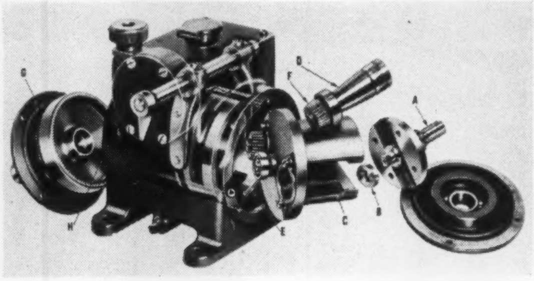
Brad Foote's GEARS REDUCERS

The Brad Foote organization's constant development work — its large modern plant—much of its equipment specially designed — assure gears in any material —all types — sizes.

write for NEW DATA BOOK

FOOTE GEAR WORKS INC.
1301 S. CICERO AVE., CICERO, ILL.

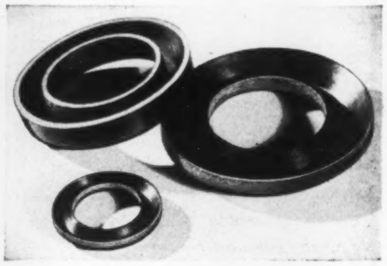
mission is especially advantageous. Operation of the unit is based on the principle of a ring of fixed diameter in contact with conical rollers, the speed ratio depending on the ratio of the diameter of the ring to the diameter of the rollers at the point of contact. Sizes are from 1/6 to 15 horsepower, the smallest being only 5 by 8 inches overall.



Driving pressure is made to correspond simultaneously to the input torque and the speed ratio

Leather Packings Stand High Pressure

SPECIALLY treated leather packings for applications where medium high temperatures and high pressures are experienced have been placed on the market by The Garlock Packing Co., Palmyra, N. Y. Named Bitan packings, they are resistant to acid and alkaline solutions as well as high temperatures and pressures. The packings are available in all types and forms and include cups, flange or hat packings, "U" packings and washers, gaskets or disks.



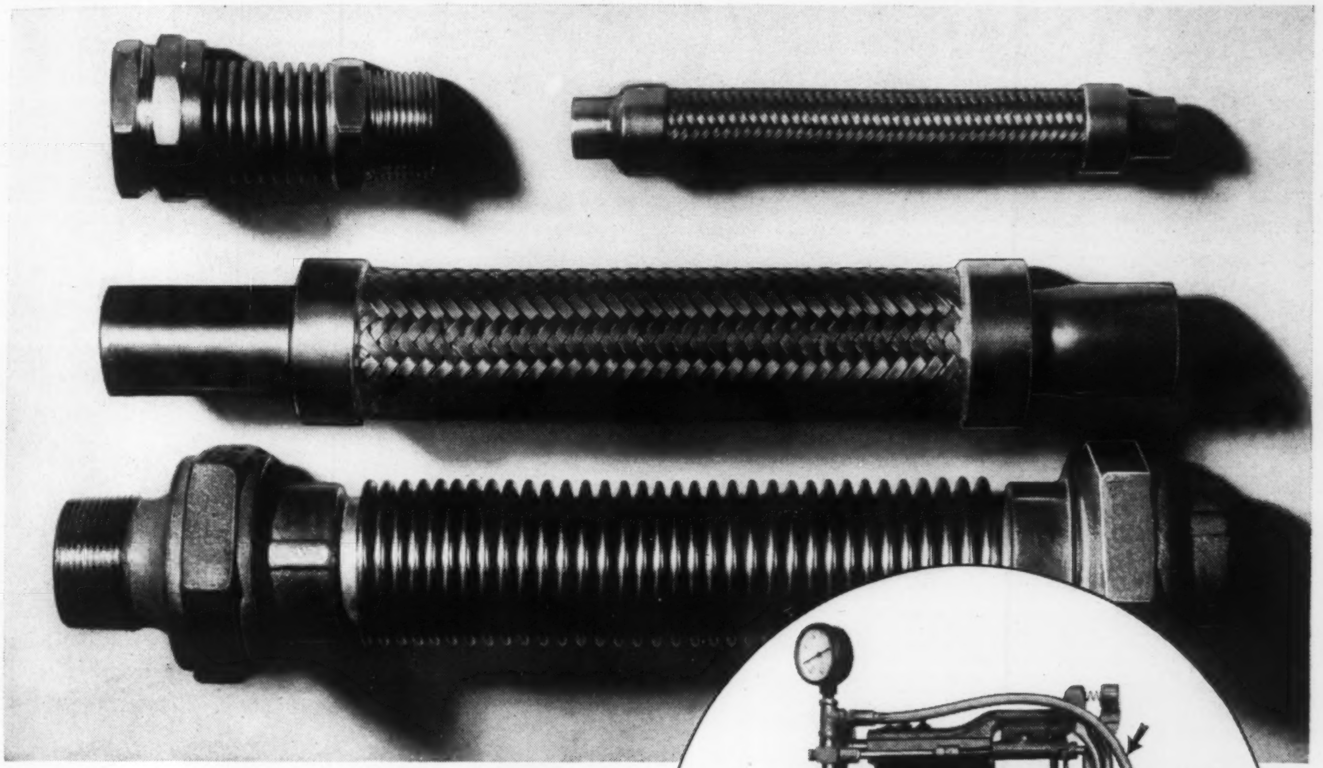
Treated leather packings are resistant to acid and alkaline solutions and withstand medium high temperatures

Ball Bearings for Special Uses

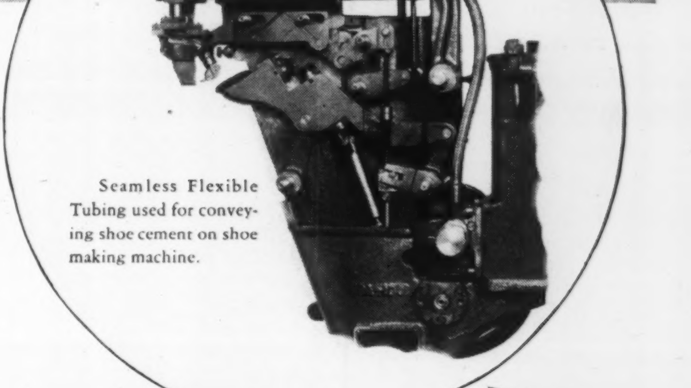
LINE of commercial ball bearings, developed primarily for roller conveyor and trolleys, but well adapted to casters, dollies, hand trucks, turntable designs, shelf rollers, guide rolls, etc. has been placed on the market by Palmer-Bee Co., Detroit. Capacities range from 30 to 2250 pounds per bearing. Inner ball race is made of cold drawn steel, finished on screw machine. Bore is broached hexagonally, forming a perfect lock on hexagon axle. Outer race is coined under 300-ton pressure, giving a burnished, perfect diameter surface just

Seamless *Flexible* Connectors

...THE SAFETY LINK BETWEEN TWO MOVING PARTS



Assemblies of American Seamless Flexible Bronze Tubing with various types of end fittings used as leak-proof flexible connectors for taking up vibration, misalignment, etc.



Seamless Flexible Tubing used for conveying shoe cement on shoe making machine.

INSTALL American Seamless Flexible Bronze Tubing as original parts on your product. It's cheap insurance against the need for future servicing. Wherever you need a flexible connector or conductor... for misaligned or moving parts, for complete elimination of vibration...the only 100% safe answer is American Seamless Flexible Bronze Tubing.

For the conveyance of air, water, oil, steam or fuel, "American" has no superior. No joints, welds, laps, seams or packing are used in its manufacture. *It's seamless.* That's why it's leak-proof, and that's why more and more designers of machinery of all types are putting "American Seamless" into their specifications.

Write us about your connector problems. Our engineering department has a wealth of information on the use of "American Seamless" on all types of machinery. Consultation of this department entails no obligation. 38322

ANACONDA
from mine to consumer

FREE REFERENCE HANDBOOK ON SEAMLESS FLEXIBLE METAL TUBING

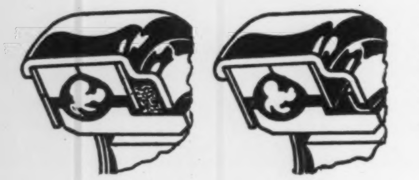
The most dependable *flexible* connector for conveying liquids or gases under high pressures . . . made from special high tensile strength *seamless* Bronze Tubing. Handbook contains descriptions, illustrations and valuable engineering data. Write for Bulletin SS-3.

THE AMERICAN BRASS COMPANY

American Metal Hose Branch

General Offices: WATERBURY, CONNECTICUT

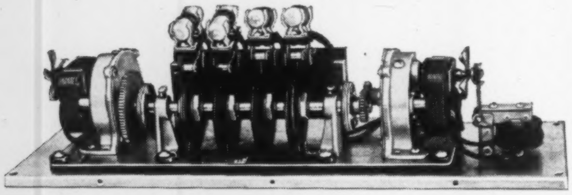
below the centerline. Races, balls and seals are assembled in place. Rim is then flanged down, forming a compact component bearing unit. Steel seals are pressed sheet metal, fitted close enough to retain grease but not cause friction. Bearings are made in outside diameters ranging from ⅞ to 3 9/16 inches to fit hexagon from 5/16 to 1¼ inches.



Inner ball race of bearing is made of cold drawn steel. Steel shields are closely fitted to retain grease

Controller Operates on New Principle

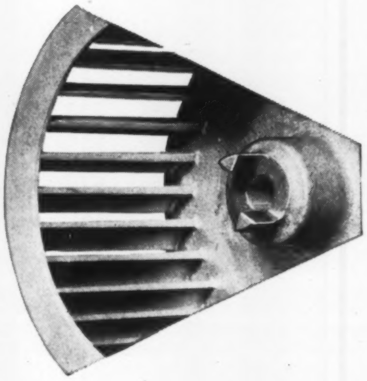
RE-CYCLING operations of a time cycle controller for multiple electric circuit operations have been reduced to simplicity by a new two-speed controller now being manufactured by Electric Switch Corp., Columbus, Ind. The Model 635 controller utilizes varied speeds on its single camshaft, a new principle in commercial controller construction. Motors with different speeds are placed at either end of the camshaft and, utilizing speed reducers and overriding clutches, the cycling operation is accelerated or slowed at any point in the cycle. Acceleration and deceleration may be completely automatic, controlled by a mercury switch operated by one of the cams, or controlled by pushbuttons.



Motors with different speeds are placed at either end of camshaft, allowing shaft to be accelerated or slowed

Blower and Hub Cast Integrally

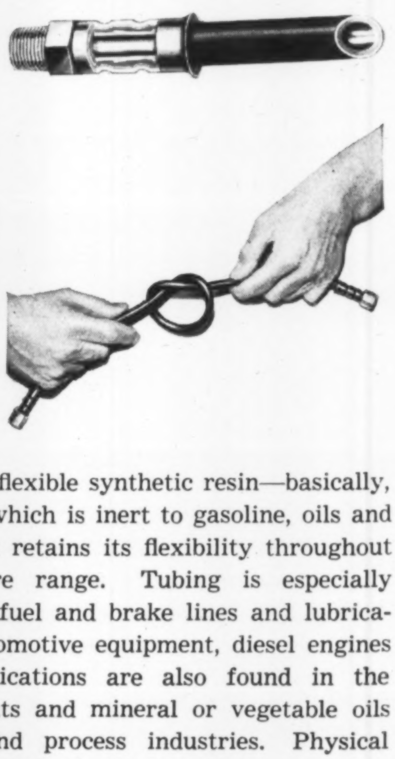
NEW type blower fan with the hub cast to form the driven unit of a flexible coupling, marketed under the trade name "castalu" has been brought out by Advance Aluminum Castings Corp., 2742 West 36th Place, Chicago. Cast in one piece of aluminum, the fan is designed for oil burners, stokers, air conditioning equipment and similar devices. By having the flexible coupling unit as an integral part of the fan, motors having standard shafts can be used and approximately one-third of the cost of flexible coupling is saved. Blower is also available with grooved hubs for belt drive in either single, double or triple groove style. Due to its lightness, fan is comparatively free from vibration and requires minimum power for starting. Castalu fans operate either clockwise or counter-clockwise and are available in all standard sizes from 3 x 1½ inches to 10½ x 5¼ inches and bored to suit any shaft.



Flexible coupling unit is cast as integral part of aluminum blower. Blower is also available with grooved pulley for V-belt

Flexible Tubing Resists Corrosion

FLEXIBLE tubing resistant to the corrosive effect of oils and solvents with inside diameters up to ½ inch has been developed by Resistoflex Corp., 370 Lexington avenue, New York. "Resistoflex" is the tradename of a flexible synthetic resin—basically, polyvinyl alcohol—which is inert to gasoline, oils and organic solvents. It retains its flexibility throughout a wide temperature range. Tubing is especially adapted for use as fuel and brake lines and lubrication systems of automotive equipment, diesel engines and aircraft. Applications are also found in the conveying of solvents and mineral or vegetable oils in the chemical and process industries. Physical characteristics of "Resistoflex" include lightness (specific gravity is approximately 1.26) great toughness, pressure resistance, good elasticity and extreme



Flexible tubing of synthetic resin retains flexibility throughout wide temperature range and is resistant to corrosive elements

(*Continued on Page* 55)

(*Continued from Page* 52)

flexibility. Tubing is available in standard sizes with specially designed couplings.

Timer Has Easily Adjusted Dial

AUTOMATIC time switch (type TSA-14) has recently been announced by General Electric Co., Schenectady, N. Y., for use in a wide variety of applications such as process timing and sign flashing. The total time cycle of each switch is fixed dependably and accurately as the contact-making mechanism is driven through a spur gear train by a synchronous motor. The dial of the instrument is marked in "per cent of total time." The percentage of "on" time may be varied by the user merely by rotating the dial until the desired percentage on "on" time is indicated by the pointer. One of the features of switch is the pipe nipple on die-cast base to allow easy mounting in a knockout of any convenient junction or switch box.

Pipe nipple on die-cast base of time control unit allows easy mounting in junction or switch box

Woven Glass Is Base of Plastic

BAKELITE laminated material using a woven glass fabric base instead of the usual paper or fabric has been introduced by Synthane Corp., Oaks, Pa. Glass gives low moisture absorption which has not been duplicated previously in laminated phenolic resinoid materials. Other advantages reported are a minimum change in electrical characteristics and greater resistance to the action of corrosive liquids.

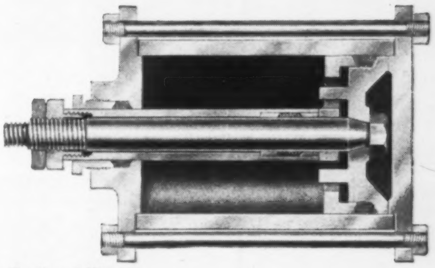
Variable Speed Unit Is Announced

SIMPLE, positive mechanism for governing the speed of output shafts through an infinite number of variations within the range of the unit has been developed by Morse Chain Co., Ithaca, N. Y. With the input shaft operating at the recommended speed of 180 R.P.M., the variable speed control can be

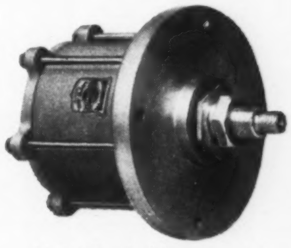
Maximum Power

AND

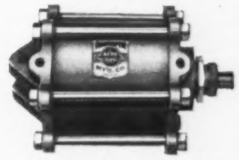
no leakage troubles



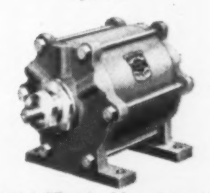
Sectional View



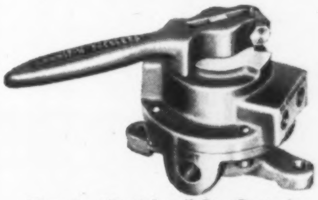
Model JR—double acting air cylinder



Model BR—double acting air cylinder



Model CR—double acting air cylinder



Hannifin "Pack-Less" Air Control Valves available in all types for positive control of air operated equipment

● Hannifin "Leakproof" Air Cylinders provide a perfect piston fit in a ground and honed cylinder bore, with provision for easy maintenance of the high efficiency piston seal. The soft graphite treated piston packing is adjusted without disturbing any other parts. The adjusting nut and tube are an integral assembly, locked in position on the threaded end of the piston rod. There can be no end play as the packing wears. Adjustment requires only loosening the lock nut and turning the adjusting tube.

Hannifin "Leakproof" Air Cylinders are built in a complete range of standard types and mountings, sizes 1 to 16 inch bore, for any length stroke. Larger sizes built to order. Single and double acting types with air cushion at either or both ends if required.

Write for Bulletin 34-MD with complete specifications.

HANNIFIN MFG. COMPANY

621-631 South Kolmar Avenue
Chicago, Illinois

Engineers • Designers • Manufacturers • Pneumatic and Hydraulic Production Tool Equipment

HANNIFIN

IMPROVED AIR CYLINDERS

3 SIZES . . .
for Horizontal or Vertical Mounting
- ROTARY GEARED MOTORPUMPS
Nos. 101 - 102 - 103

Flexible in Installation
Economical and Dependable

- Ask for details
Brown & Sharpe Mfg. Co.
Providence, R. I., U. S. A.

BROWN & SHARPE PUMPS

BS

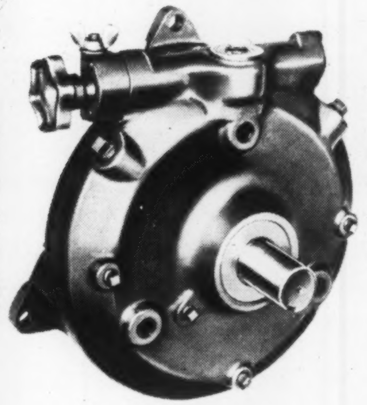
Photo courtesy The Heald Machine Co.

AVIATION'S NEW TYPE OIL LINE HOSE NOW ADAPTED TO MACHINE TOOL APPLICATIONS

Because of its all-around superiority, this new type oil line hose is now being specified by leading machine tool firms. AVIOFLEX Hose is light in weight, has great strength, and unlimited flexing life; laminated cellulose wrapping over flexible metal core renders it completely resistive to hydrocarbon fluids at all operating temperatures Data, sample, sent on request

CHICAGO METAL HOSE CORPORATION
MAYWOOD, ILLINOIS

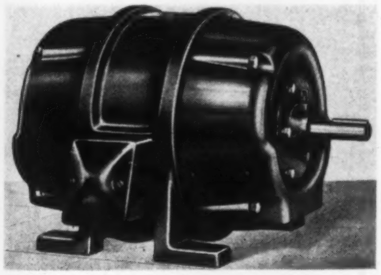
quickly adjusted by a hand set with visible dial to deliver from 1½ to 40 R.P.M. through the low speed shaft, or any speed between these two limits. The unit is well adapted for use as a feeder drive and fits logically into machines or conveyors handling grain, flour, feed, chemicals, and the handling of any dry materials. Construction of the unit is simple. It is self-contained and therefore cannot be affected by dust or dirt. It is easily installed by fastening to machine frame with three bolts.



Positive variable speed control transmission may be easily adjusted to deliver output speeds from 1½ to 40 RPM when input shaft is operating at 180 RPM

Line of Splashproof Motors Announced

DISTINCTIVE design characterizes a new line of splashproof motors placed on the market by Diehl Manufacturing Co., Elizabethport, N. J. Features include sturdy cast-iron construction, specially impregnated windings, effective baffling system to prevent water or falling particles, improved ventilation system and sealed ball bearings. Motors conform to NEMA specifications for splashproof motors and are furnished in all NEMA sizes and ratings.



Effective baffling system in new line of motors prevents water or falling particles entering inside of motors

Magnetic Contactor for Small Motors

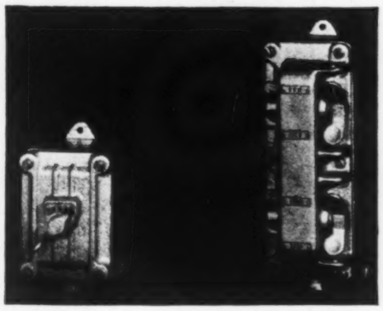
DESIGNED for small continuous duty single and poly-phase motors, an alternating current magnetic contactor (NEMA size 0, bulletin 9560) has been placed on the market by Cutler-Hammer, Inc., 328 North 12th street, Milwaukee. Long life of the silver-to-silver butt-type contacts is guaranteed by the manufacturer because their "twin-break" function reduces the arc, and operation in a restricted pocket cools it. All moving parts are pivoted and the self-aligning armature eliminates sliding friction, allows close guiding of the contact structure, insures proper alignment and good contact pressure, and maintains quiet operation. The NEMA type 1 enclosure is "airstyled," is extremely compact and has a hook-on cover removable by loosening one screw. Contactors are available in 2, 3 and 4-pole constructions with maximum ratings of 1½ horsepower for single and 2 horsepower for polyphase motors.

CUTLER-HAMMER
MOTOR CONTROL

All moving parts in magnetic contactor are pivoted, and self-aligning armature eliminates sliding friction

Pushbuttons Are Entirely Protected

DUST-TIGHT and watertight pushbutton stations for heavy duty service where protection from fumes, dust and moisture is desired are announced by Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa. They are suitable for operations where subjected to rough handling and where high control currents of magnetic controllers for large motors must be withstood for long periods of time. Stations of one to four units are available. They are of heavy cast iron finished with weatherproof aluminum paint. The mounting holes are easily accessible on outside of



Pushbuttons stations are of heavy cast iron finished with weatherproof aluminum paint

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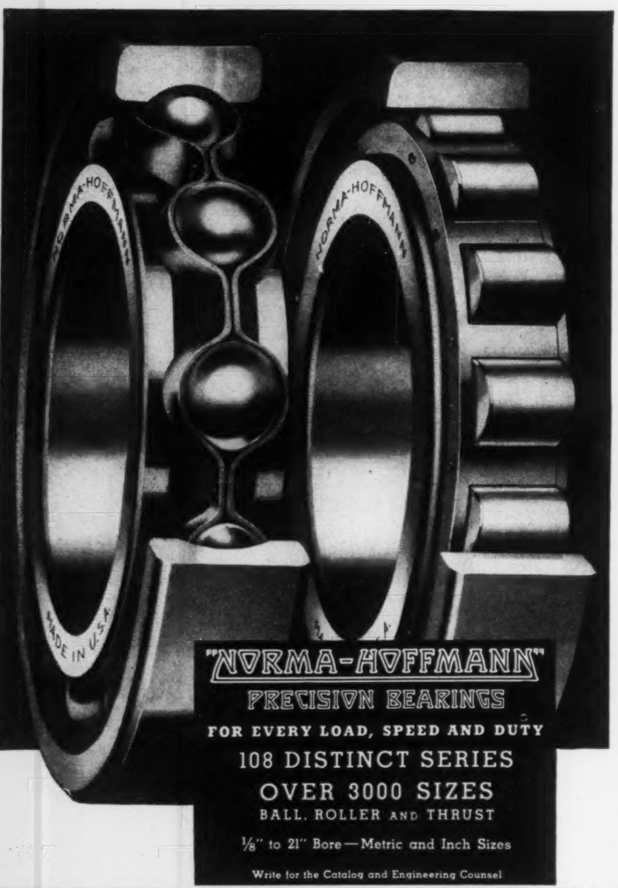

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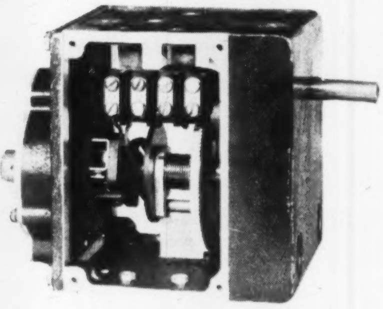
case; the cover is sealed with cork gasket and oil treated paper, and rust-resisting materials are used throughout.

Limit Switch Controls Feed Motors

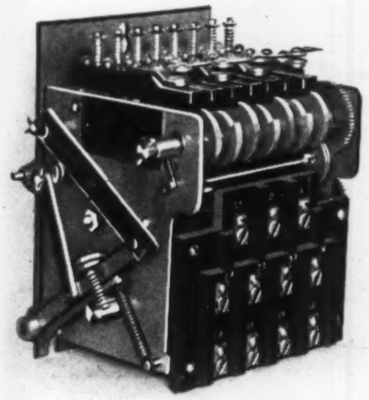
LIMIT switch, designed primarily as a means of obtaining definite, predetermined amounts of feed in planer operations, has been announced by General Electric Co., Schenectady, N. Y. The device controls the intermittent operation of the feed motor on planers, plate planers, roll grinders or machines where an intermittent feed or index, which must be adjustable and consistent in operation, is regularly repeated. Essentially the switch consists of a drive shaft connected to the feed mechanism; an indexing means for setting the amount of feed required; and a resetting mechanism for automatically bringing the switch to the zero position after each individual operation has been completed. The device is furnished in cast aluminum case.



Polyflex timer is suited for applications where timing interval between two or more contacts is required. It does not provide for visible indication of timing adjustments

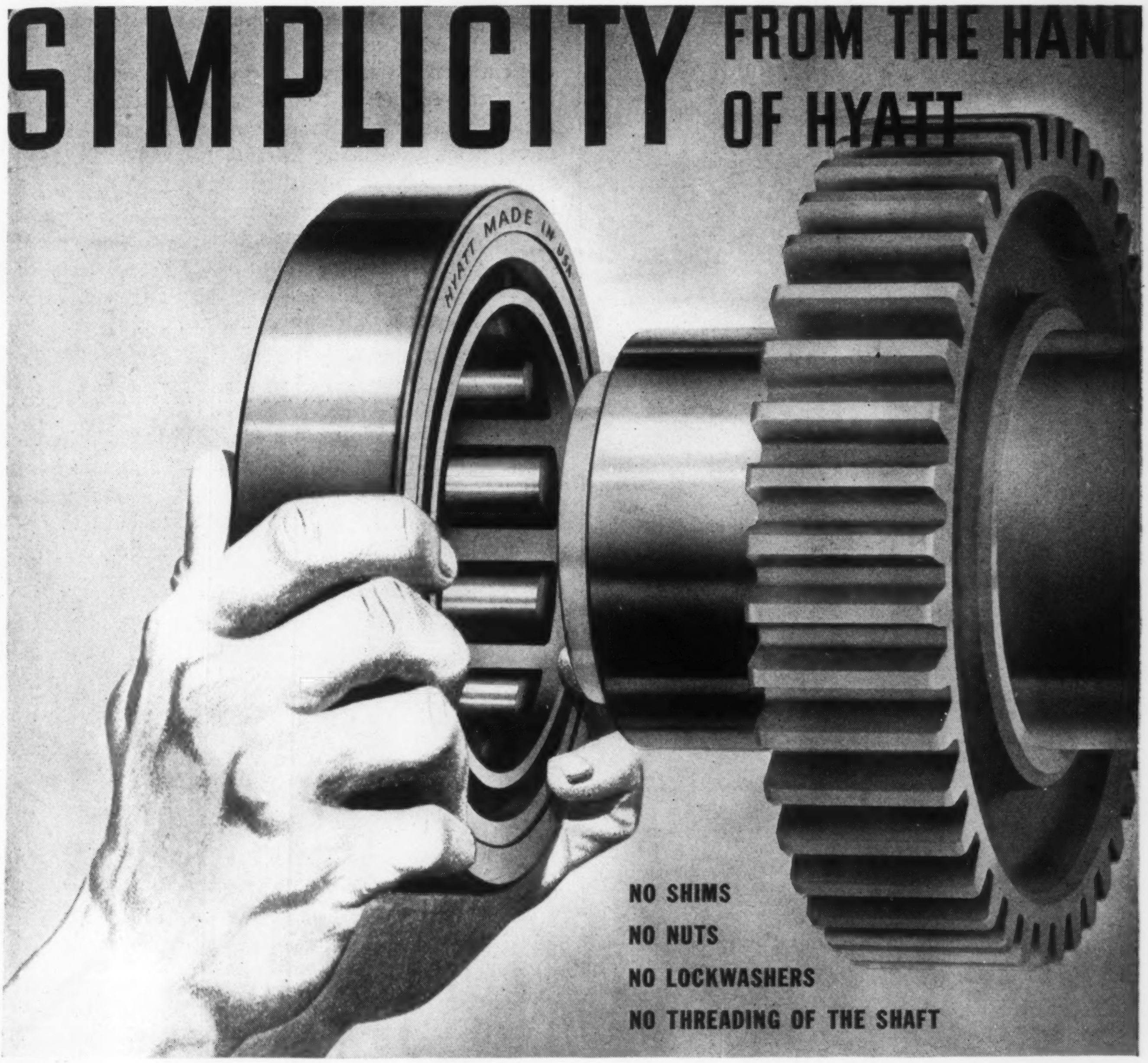
Motor Driven Time Control Offered

SYNCHRONOUS motor driven time delay relay designed for applications which do not require frequent adjustments of timing intervals has been placed on the market by Eagle Signal Corp., Moline, Ill. Known as the Polyflex timer, it does not provide for visible indication of timing adjustments, but is ideally suited for applications where a timing interval



Limit switch has drive shaft connected to feed mechanism through which control of planer or similar machine is effected

SIMPLICITY FROM THE HAN OF HYATT



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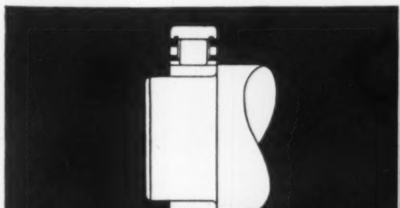
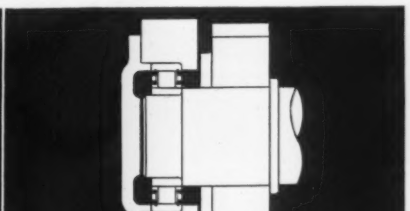

SIMPLICITY IN THE BEARING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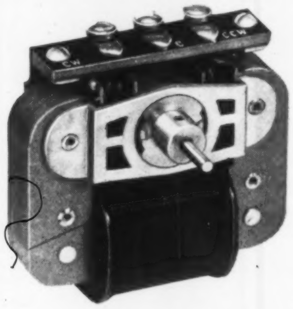
between the functioning of two or more contacts is required. When adjusted to operate with the clutch coil energized, it starts timing when a control circuit is closed. In modified form it begins timing upon the momentary closure of the control circuit and resets when the timing interval has expired. When adjusted to operate with the clutch coil de-energized, it commences its timing interval when the control circuit is opened and resets when the control circuit is closed. The device is particularly applicable to motors, deep well pumps, automatic doors, elevator controls, solenoid valves, leak alarms, etc.

Tiny Motors Are Developed

SMALL, reversible motors of .00025 to .0023 horsepower and weighing from 11 to 29 ounces have been placed on the market by Barber-Colman Co., Rockford, Ill. All standard motors are built to operate on 105-120 volts, 60 cycles, alternating current.



Small motors weigh as little as 11 ounces. They develop .00025 to .0023 horsepower

Direction of rotation is controlled by a single-pole double-throw switch in low-voltage shading circuit. Control switch may be up to 500 feet from motor, using No. 18 three-conductor wire. Special motors are available with rust resistance parts, with two-speed operation, or equipped with small fan which permits a longer running period.

Composite Rivets Have Silver Face

OFFERING users of solid silver contacts greater economy without loss of efficiency, composite silver rivets have been developed by The H. A. Wilson Co., 105 Chestnut street, Newark, N. J. Only the contact face of these rivets is silver, the under part of the head and shank being base metal, resulting in a considerable saving of silver. Backing material of composite silver rivets may be any workable base metal. Copper, bronze, nickel and steel are being used. When steel backing is used for high strength, the entire rivet may be furnished silver plated. The rivets may be used for fastening all kinds of machine parts together and are particularly adapted for electrical work.

Miniature Bearings

(*Concluded from Page* 33)

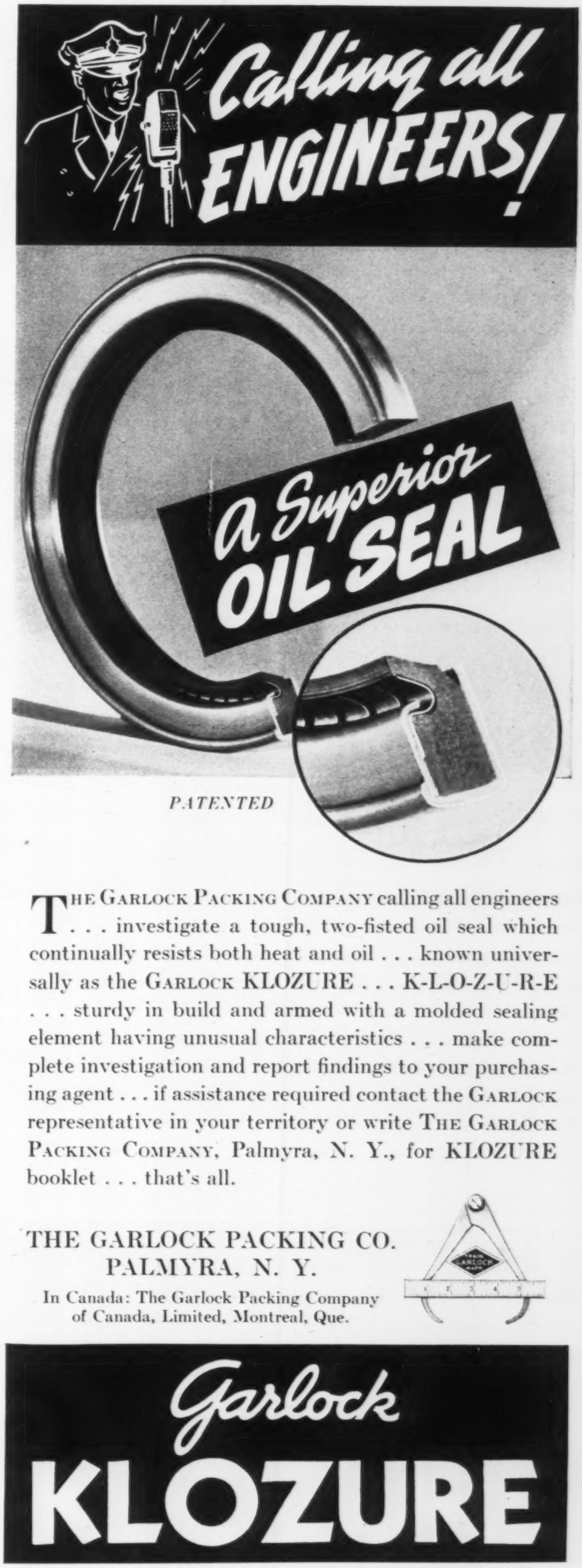
tion than a jewel; that is a ball bearing. At the present time tiny ball bearings are being tried out for many applications that formerly were fitted with jewels. *Fig.* 4 illustrates the various types that are available of these microscopic parts. Dimensions in millimeters give the smallest size of several different types. In cases where friction is low, only three balls are used; for higher frictions, four or more balls may be employed. Bearing types include those with a tapered pivot which is the smallest type, bearings which can be dismantled by withdrawing inner race without removing bearing cover, oblique bearings with heavy inner race, flexible and adjustable bearings, bearings which can withstand radial stress only and several types of radial ball bearings for taking thrust. *Fig.* 7 shows a miniature ball bearing which utilizes an adjusting screw to take up end play.

Just as plastics have been adopted for large bearing applications, so have they been utilized for miniature bearing needs. Although not having the low coefficient of friction that jewels and ball bearings possess, they do serve well in many instances. *Fig.* 3 shows the tiny bushing that is used in an automotive distributor. In such a part there is no particular call for low friction, but the absence of any lubricating liquid is important. Plastic bearings will operate with little wear in the absence of oil and for that reason they find applications where oil would be detrimental.

Bearings of other materials have been tried in small sizes, but as tolerances must be held so close, materials that have any tendency to shrink or expand are unsuitable. Plastics must be loosely fitted to operate satisfactorily. Composition oilless metal bearings work out well in miniature sizes although some difficulty is usually experienced in making them in the very small diameters. Special pivot bearings utilizing two metals rather than a steel pivot and a jewel are quite successful and cheaper than jewel bearings. Beryllium copper is often used for the seat of a pivot bearing. These would not perform, however, if there were any load or if the bearing turned at high speed.

The type of application usually dictates the miniature bearing to be used. Especially in the smaller types the fields for which certain bearings are suitable are definitely prescribed. Greatest consideration today by the designer must be his selection of jewels or miniature ball bearings. Probably antifriction bearings will displace jewels in certain applications in new machines.

For valued assistance in the preparation of this article MACHINE DESIGN wishes to thank Bakelite Corp., Bound Brook Oil-Less Bearing Co., Norma-Hoffman Bearings Corp., General Plastics Inc., Hamilton Watch Co., Landis & Gyr Inc., Sangamo Electric Co., and Westinghouse Electric & Mfg. Co.



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ALLOYS (BRONZE)—Catalog No. 21 gives data on the many grades of Ampco metal, its resistance to corrosion, machining properties, welding properties and other information, including applications. The catalog is available through Ampco Metal Inc., Milwaukee, or The Wellman Bronze and Aluminum Co., 6017 Superior avenue, Cleveland.

ALLOYS (NICKEL)—Incorporating the latest additions and revisions in the SAE steel specifications, revised data sheet, section VII No. 1, "Society of Automotive Engineers Standard Specifications for Steel" has been issued bv The International Nickel Co., 67 Wall street, New York.

BEARINGS—Description and specifications of supersealed roller bearing pillow blocks made by Shafer Bearing Corp., 35 East Wacker Drive, Chicago, are given in bulletin 521 issued by the company.

BEARINGS—Information on the many sizes of three types of bearings: Oil retaining bronze, graphite inlaid bronze and impregnated hard wood bearings, made by Bound Brook Oil-Less Bearing Co., Bound Brook, N. J., are given in a booklet issued by the company.

BEARINGS — Illustrations showing one-piece, two-piece, plain and flange type oilless bronze bearings are contained in a folder of R. W. Rhodes Metaline Co. Inc., P. O. Box No. 1, Long Island City, N. Y.

BELTS—Information on Whipcord endless belts and illustrations of their applications to machines are contained in a leaflet of The Manhattan Rubber Mfg. Division of Raybestos-Manhattan, Inc., Passaic, N. J.

CASTINGS—Rough, finished and heat-treated steel castings of all types and shapes are described and illustrated in a 25-page booklet of National-Erie Corp., Erie, Pa.

CONTROLS (ELECTRICAL) — Bulletin No. 373 of Bender Warrick Corp., Birmingham, Mich., gives information on relays, electrode holders and other equipment for floatless pump controls. No moving parts are necessary for measuring the level of liquids.

CONTROLS (ELECTRICAL) — "Type HD Heavy Duty Pushbutton Stations" is the title of a bulletin recently published by Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

CONTROLS (ELECTRICAL)—De-ion non-reversing linestarters, designed for applications where overall dimensions are not limited are described in a leaflet published by Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

CONVEYING MACHINERY — Palmer-Bee Co., Detroit, has issued separately section 112 of its general catalog 100 covering its commercial ball bearing line, precision tapered roller line and precision ball bearing line and their application to materials handling parts.

ELECTRICAL ACCESSORIES — Enlarged catalog No. 17 of stock rheostats and resistance units for the industrial, radio and electronic fields has been released by Ohmite Manufacturing Co., 4835 West Flournoy street, Chicago.

ENGINEERING DEPARTMENT EQUIPMENT — Booklet of The Haloid Co., Rochester, N. Y., describes and illustrates the various models of commercial rectigraph and rectigraph daylight duplex photo-recording equipment. It gives the story of the photo-copying machine for every purpose.

ENGINEERING DEPARTMENT — Recent developments in printing, industrial finishing, textile coloring, etc., and the interrelation of advances in these fields to other industries is covered in a booklet just released by Interchemical Corp., New York.

EQUIPMENT—Self-contained drilling and tapping heads for building into machines are described in bulletin 5—38 issued by Kingsbury Machine Tool Corp., Keene, N. H.

FASTENINGS—Bulletin of The H. A. Wilson Co., 105 Chestnut street, Newark, N. J., gives information and specifications on composite silver rivets, a new construction offering users of solid silver contacts greater economy without loss of efficiency.

FASTENINGS—Folder issued by The Fanner Manufacturing Co., Brookside Park, Cleveland, gives information on a combination safety hook bolt head and deep washer to convert ordinary bolts into hook bolts. Various applications of this construction are shown.

MOTORS—Bulletin No. 1022 illustrates and gives data on the more than 60 types of small motors equipped with speed reducers ranging from 1/400 to 1/6 horsepower made by Bodine Electric Co., 2254 West Ohio street, Chicago.

MOTORS—Sterling Electric Motors Inc., 5401 Telegraph Road, Los Angeles, has just issued a folder describing the enclosed motors made by the company and the patented herringbone rotor which is an exclusive feature of Sterling Motors.

MOTORS—Bulletin M-2, "P&H Convertible Slip Ring Motors", gives a thorough analysis of the requirements demanded of standard rotor type of slip ring motor

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